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SOIL SURVEY
WICHITA COUNTY, TEXAS

BY

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By WILLIAM T. CARTER, in Charge, and W. W. STRIKE, U. S. Department of Agriculture, and H. V. GEIB and E. H. TEMPLIN, Texas Agricultural Experiment Station

COUNTY SURVEYED

Wichita County is in the extreme northern part of Texas in the region generally spoken of as northwest Texas, but it is almost equidistant from the east and west sides of the State. Red River, which forms the irregular northern boundary, separates Wichita County from the State of Oklahoma. The county is roughly quadrangular in shape and has an area of 624 square miles. Included in this survey are 16 square miles in Tillman County, Okla., and 3 square miles in Cotton County, Okla., making a total of 643 square miles, or 411,520 acres.

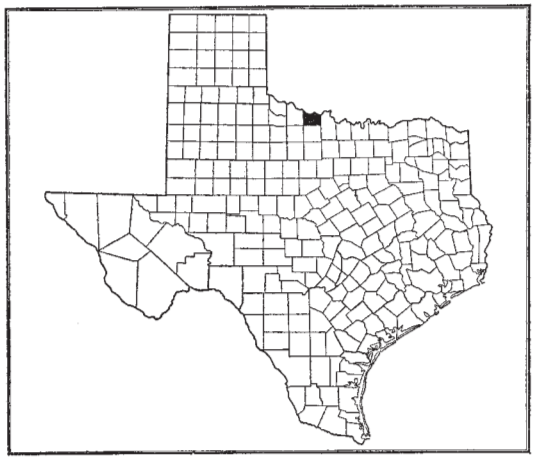

FIGURE 1.—Sketch map showing location of Wichita County, Tex.

Wichita County lies in the eastern section of the Red Beds plains, an extensive region extending for many miles to the south and west. It consists of smooth, rolling plains, with rounded slopes and shallow, comparatively broad valleys. The region lacks the flatness of the high plains west of it and the angularity of the limestone country east of it.

The Valley of Red River, extending across the northern part of the county, and that of Wichita River, across the southern part, approach each other toward the east and join a few miles east of the northeastern corner of the county. Small tributary interior valleys join these main valleys. These have their source in a narrow divide in the north-central part of the county and extend north and northeast to the Valley of Red River and south and southeast to Wichita Valley. These smaller valleys, flat-bottomed and narrow, are bordered by gentle prairie slopes in their upper parts and by deeper, steep-walled slopes downstream. The Valley of Red River is a flat-bottomed, steep-walled, winding trench. It consists

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chiefly of a bed of loose sand without vegetation. It is bordered in places by a slightly higher area, largely covered by small sand dunes.

Wichita County was formed from Clay County in 1882. During the early history of Texas trails crossed what is now Wichita County from east to west and from north to south. It is reported that one settler lived near the mouth of Gilbert Creek prior to the Civil War, but the first permanent settlements of importance were made in the decade from 1870 to 1880. Although many of the early settlers were from other parts of Texas, some were from other States. Later settlements were made in the northwestern part of the county, chiefly by people of German descent from some of the Northern States.

The population of the county in 1920 is given in the census report as 72,911, of which 22,788, or 31.3 per cent, are classed as rural. During the last 10 years the population has increased greatly because of the development of the oil industry. The county is most thickly settled in the eastern part and in a strip across the northern part, just south of the Red River Valley. The most thinly settled section is in the southwestern part.

The population of the county is almost entirely white. The very few negroes live mostly in the larger towns. The census gives the density of the rural population as 37.7 persons to the square mile. Several thousand people live in the small towns.

Wichita Falls, with a population estimated in 1924 at about 51,000, is the largest city and the county seat. It has grown within the last few years from a small town to a cosmopolitan city of importance as an oil and railroad center. It is the distributing point for wholesale houses and the headquarters for a number of oil companies. Besides several large oil refineries, there are a number of other manufacturing establishments. The largest flour mill in the State is located there. Burkburnett, Iowa Park, and Electra are other important towns. The oil industry is being developed at the present time in various parts of the county, and there is much activity in drilling.

The Fort Worth & Denver City, the Wichita Valley, the Wichita Falls & Oklahoma, the Wichita Falls & Southern, and the Missouri, Kansas & Texas Railways afford transportation facilities to various parts of the county.

Public roads extend to all parts of the county. About 66 miles of the roads are improved concrete highways, and other improved roads are in the process of construction. Some of the main roads are surfaced with gravel. The dirt roads are graded and kept in fairly good condition, but in protracted rainy seasons they sometimes become too muddy for automobile travel. Considerable satisfactory road-building material is found at various places in the county. Telephone service and rural mail delivery reach most of the rural homes, and there are many schoolhouses and churches throughout the county.

Local markets absorb all the farm products except beef cattle, wheat, and cotton. The towns of the county and the oil centers

consume considerable quantities of imported vegetables, butter, and fruit. Cattle are shipped to Fort Worth and to Central-Western States for fattening. The cotton is exported, as is also that part of the wheat crop which is not locally manufactured into flour.

CLIMATE

The climate of Wichita County is temperate and subhumid. The summers are long and the winters short. The usual winter weather consists of cool, mainly clear weather with westerly winds of moderate strength, followed by a period of warmer weather with moderate or strong southerly winds. Such periods may be terminated very suddenly by a shift of the wind to the northwest, with a sudden sharp drop in temperature. The following period of cold, windy weather, called a norther, lasts from two to four days and is followed by gradually rising temperature and decreasing winds. The northers are only moderately cold during November and December, are rather severe in January and February, and during March are infrequent and less intense, though the weather is still rather cold. The spring weather is pleasant, in spite of some rather strong winds from the south, and the summers are warm with some very hot days, though the nights are usually pleasant. Hot winds occasionally do considerable damage to crops during the summer. Long periods of hot and very dry weather frequently occur, but the heat is usually tempered by southerly breezes throughout the summer.

The average date of the last killing frost is March 30 and of the first is November 8. This gives an average frost-free season of 223 days. The latest killing frost recorded occurred on May 1 and the earliest on October 19. There is, therefore, ample time for the maturing of all crops commonly grown in the county. Frosts and freezes occasionally damage or entirely destroy fruit crops by killing buds which have come out after periods of warm weather early in the spring or late in the winter. Only a little snow falls, and this melts rapidly.

The spring months have the highest rainfall. The precipitation grows gradually less and is lowest in the winter. However, the seasons vary considerably from year to year, as is evidenced by the fact that in 1896 only 12.38 inches of rain fell at Wichita Falls, whereas in 1919 there was a precipitation of 47.15 inches. Periods of several years, when the rainfall is ample for crops, are followed by periods of several years when the rainfall is very light. Evaporation of moisture by heat and strong winds is considerable.

Although winds are sometimes very high, destructive storms are rare. Local hailstorms sometimes destroy crops.

Tables 1 and 2 give the normal monthly, seasonal, and annual temperature and precipitation at Henrietta, in Clay County, and the precipitation at Wichita Falls.

TABLE 1.—*Normal, monthly, seasonal, and annual temperature and precipitation at Henrietta, Clay County*

[Elevation, 915 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1896)	Total amount for the wettest year (1915)	Snow, average depth
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	43.3	84	2	1.23	1.87	0.55	0.5
January	41.9	91	−1	.99	.99	.90	1.1
February	44.3	94	−3	1.15	.57	2.15	1.4
Winter	43.2	94	−3	3.37	3.43	3.60	3.0
March	54.1	98	13	1.55	.94	.93	.2
April	62.4	99	23	3.26	1.14	7.87	.0
May	71.2	105	32	3.80	.20	5.42	.0
Spring	62.6	105	13	8.61	2.28	14.22	.2
June	80.1	116	42	3.23	.40	9.70	.0
July	84.4	110	55	2.05	2.14	1.62	.0
August	84.0	112	50	2.82	.84	6.60	.0
Summer	82.8	116	42	8.10	3.38	17.92	.0
September	77.3	110	38	2.35	.72	4.90	.0
October	65.1	101	19	2.36	.89	3.83	.0
November	52.9	91	7	1.94	1.95	.40	.1
Fall	65.1	110	7	6.65	3.56	9.13	.1
Year	63.4	116	−3	26.73	12.65	44.87	3.3

TABLE 2.—*Normal, monthly, seasonal, and annual precipitation at Wichita Falls*

[Elevation, 958 feet]

Month	Precipitation			
	Mean	Total amount for the driest year (1896)	Total amount for the wettest year (1919)	Snow, average depth
	Inches	*Inches*	*Inches*	*Inches*
December	1.67	2.54	0.00	1.1
January	.99	.99	3.05	1.8
February	.97	.57	1.20	2.0
Winter	3.63	4.10	4.25	4.9
March	1.85	.94	3.05	.2
April	2.83	.20	1.50	.0
May	5.06	.40	9.90	.0
Spring	9.74	1.54	14.45	.2
June	3.52	2.14	7.15	.0
July	2.58	.32	2.90	.0
August	2.22	.36	1.40	.0
Summer	8.32	2.82	11.45	.0
September	2.62	.92	6.50	.0
October	2.25	1.07	7.95	.0
November	1.88	1.93	2.55	.4
Fall	6.75	3.92	17.00	.4
Year	28.44	12.38	47.15	5.5

AGRICULTURE

The first industry of the region now included within the limits of Wichita County was stock raising. Large ranch outfits superintended the grazing of many cattle over the free range on the State lands. Later the State lands were surveyed and sold, chiefly to ranchmen. Between 1870 and 1880 most of the county was inhabited by ranchers. A few farmers drifted in during the latter part of that decade and engaged in the growing of corn, cotton, wheat, and oats. The Fort Worth & Denver City Railway, built in 1882, afforded access to outside markets and stimulated settlement by farmers. Wheat soon attained preeminence as the cash crop and has continued to lead all other crops in acreage. With increasing settlement more and more land was put in cultivation and the ranching industry declined.

The period from 1880 to 1890 witnessed the most rapid increase of settlement in the county, the population in that time growing from less than 500 to nearly 5,000. During this period farming on the western ranges was greatly encouraged by the introduction of barbed wire as a fencing material. By 1910 the population had increased to 16,094. Between 1910 and 1920 the increase was very rapid, owing largely to the development of oil fields.

There were but 60 farms, averaging 160 acres, in the county at the time of its organization. The number of farms increased slowly to a total of 1,039, averaging 314.4 acres, in 1910. Of this land an average of 168.1 acres was improved. The discovery of oil about that time, though bringing much wealth into the county, resulted in a setback to agricultural development. After 1912 considerable areas of farm land were included in the oil fields, and the number of farms had decreased to 750 in 1920. The area of improved farming land also underwent a decrease of slightly more than 40 per cent.

Table 3, giving data recorded by the United States census, shows the development and trend of agriculture by decades since 1879.

TABLE 3.—*Acreage and production of principal crops in Wichita County, by decades, 1879 to 1919*

Crop	1879		1889		1899		1909		1919	
	Acres	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*
Corn	1,361	18,525	4,992	139,293	8,414	191,060	46,215	765,580	7,813	173,099
Wheat	50	532	5,300	83,053	48,212	333,990	33,000	197,637	68,336	880,011
Oats	10	70	5,702	152,843	20,995	392,530	7,214	72,007	11,643	363,250
Grain sorghum							349	3,959	2,684	48,765
Barley									675	19,980
						Tons		*Tons*		*Tons*
Millet and Hungarian grasses					2,516	3,940	2,459	2,437		
Coarse forage					1,452	3,309	1,593	1,868	4,697	7,209
		Bales		*Bales*		*Bales*		*Bales*		*Bales*
Cotton	103	43	1,250	470	304	45	23,794	6,382	10,661	4,901

There were in the county in 1919 more than 6,000 fruit trees, mainly peach, producing about 3,500 bushels of fruit. The year 1919 was one of favorable rainfall and generally good yields of all crops. The value of cereals produced was $2,426,040; of hay and forage

crops, $195,962; of vegetables, $38,206; of fruits, $5,875; and of all other crops, $984,183.

The value of animals sold and slaughtered in 1899 was $332,069 and in 1909 was $259,350. The value of dairy products in 1899, excluding those for home use, was $11,255 and in 1909 was $50,849. The number of cattle in the county January 1, 1920, is given as 16,406, with a value of $827,865. Of this number, 11,828 were beef cattle, valued at $577,938, and 4,578 were dairy cattle, valued at $249,927. There were 3,260 swine, valued at $59,160, and poultry were valued at $52,383. Dairy products in 1919 were valued at $158,903 and chickens and eggs produced on farms at $126,167.

The present type of general farming has been in vogue since the beginning of a permanent system of agriculture in the county. This has meant the gradual encroachment of farms on the ranch lands, with a consequent steady decrease in the ranching industry, until now the chief grazing areas are found only in certain sections of the west-central and southwestern parts of the county. The present agriculture consists of the production of the general farm crops, wheat and cotton being the main cash crops. Each farmer grows some oats, grain sorghums, forage, and sometimes corn for feed. On account of the high price of cotton prevailing during the last few years more land has been devoted to that crop and less to wheat. It is reported that about 5,000 bales of cotton were grown in 1923 and about 420,000 bushels of wheat. This was a year of light rainfall, and average yields of crops were low. Some farmers grow wheat only and some cotton only for their cash crop. It is said that most farmers utilize about one-fourth as much land for oats as for wheat. The small quantities of forage grown include sorgo (sweet sorghum) and in some sections Sudan grass. Vegetables are grown commercially only around the larger towns.

Wheat is grown to some extent by most farmers and some put in several hundred acres annually. It is grown on most of the soils of the county, but in very dry seasons the best yields are obtained on the loamy and sandy soils, such as those of the Enterprise series. Wheat yields vary greatly according to the season, very low yields being obtained in years of excessive drought. The usual yield for the county is about 12 bushels to the acre. Soft wheat is grown principally, Mediterranean being the most popular variety, although some Fulcaster and Stoner (Miracle) are grown. Some hard wheat of the Kanred and Turkey (Turkey Red) varieties is also grown. These hard varieties, which are said to be resistant to insect pests and rust and which also seem to produce somewhat higher yields, are gaining in popularity. The high-grade soft wheat is shipped in large quantities to the big milling centers of the United States, where it is blended with hard wheat in the manufacture of flour of high quality. Some of the hard wheat is milled locally and some is exported. Much of the flour manufactured locally is exported to Mexico, Cuba, Central America, and northern countries of South America, some going as far south as Brazil. It is said that much of the wheat is a mixture of hard and soft varieties, as a result of volunteer wheat of some varieties coming up in fields sowed to other varieties. Wheat of the best grade grown here is noted for producing excellent flour.

Oats follow wheat in acreage and are grown on most farms for local use. Oats are grown on all kinds of soils, and it is reported locally that the crop does better than wheat on the sandy soils. In good seasons the yield ranges from 30 to 50 bushels to the acre and is occasionally higher on the most favorable soil, but the average yield probably does not exceed 25 bushels. The chief variety is the Red Rustproof (Red Texas). Practically all of the oats grown is consumed locally by the farm livestock.

The cash crop second in importance is cotton. This is grown on many farms, sometimes in connection with wheat and sometimes as the only cash crop. The yields vary largely, depending on the season. Yields are frequently low on account of dry weather. Cotton is grown on most of the soils, but in very dry seasons the best yields come from Enterprise loamy very fine sand and Enterprise very fine sandy loam. Cotton is said to withstand drought better than any other crop. The chief variety is Mebane, though some Half-and-Half, Kasch, Acala, Lone Star, and Rowden are grown.

As a rule, the boll weevil is not a serious menace, although in 1916 and 1921 this pest did considerable damage. The acreage devoted to cotton is being rapidly increased, owing to recent high prices received for it and perhaps to the low price obtained for wheat. In good seasons the average yield for the county is about one-half bale to the acre.

Corn is grown on many soils, but in dry seasons yields are most certain on the alluvial lands and the sandy soils of the Enterprise series. Frequently corn makes a fine growth, only to be damaged or ruined by dry periods just before fruiting. It is a very uncertain crop, owing to the variable rainfall, but many farmers undertake its production nearly every year. In 1919, a very favorable crop year, the average yield of corn for the county was more than 24 bushels to the acre, but this is above the normal yield. Under conditions prevailing in the region it has been found that the best varieties, in the order named, are: Surcropper, Reid Yellow Dent, and Strawberry Dent. All the corn grown in the county is used locally.

The grain sorghums are grown by most farmers but not so extensively as in the more western section of the State. Although they rank second to cotton in drought resistance, during excessively dry years the yields are low. Kafir and milo are grown by a number of farmers, the Dwarf Yellow variety of milo and Blackhull kafir being the varieties commonly produced. Spur feterita seems to be the best grain sorghum for the region, as it is said to be less subject to insect pests than either kafir or milo. It is being grown more extensively every year. Darso is successfully grown by some farmers. It apparently withstands extremely dry conditions better than any of the other grain sorghums. The yield of the grain sorghums is about 1 ton of heads to the acre in good seasons, or about 27 or 28 bushels of threshed grain. As most of the crop is fed on the farms or sold for local feeding it is used without being threshed.

Barley has long been grown on a small scale by many farmers. It is a valuable feed for livestock of all kinds, and for this reason takes the places of oats on many farms. It yields somewhat less than oats. It is used also for grazing, being sowed at about the same time as wheat.

Sorgo for use as forage is grown on small areas on most farms. It is a rather certain crop, as some is usually produced even in very dry seasons. The Sumac or Red Top variety predominates.

Sudan grass is grown by many farmers, and the acreage is being rapidly increased. This crop is especially valuable for summer grazing or it may be cut for hay. It is planted in rows and cultivated. It withstands dry conditions rather well, and with plenty of moisture yields from 1 to 3 tons of hay to the acre a season, from the customary two cuttings.

It would seem that broomcorn could be grown successfully, but it has not become an established crop.

Millet is grown for forage in small areas by many farmers, is very successful, and does well in dry seasons. It makes a quick growth and may be sown either in fall or spring, thus furnishing forage at times when other feed is scarce. The varieties grown are German and Pearl. Yields ordinarily are from 1 to 1½ tons to the acre.

Alfalfa has been tried on a number of farms in the county, with good results in several places, but it is often damaged or killed by root rot. Only a few small fields were seen during the progress of the survey. Doubtless alfalfa can be successfully grown on several of the soils that will be available for irrigation on the completion of the present project.

Peanuts are not grown extensively, although they have been produced for feeding hogs on some of the sandy soils. One objection to the growing of peanuts is that the soil blows badly after the crop is harvested.

Small acreages of sweet clover are grown. Johnson grass is cut for hay on some of the alluvial lands in the eastern part of the county. It is usually cut twice a season, with yields ranging from 1 to 3 tons to the acre for the season. It does well, producing at least fair yields even in dry seasons. It is a serious pest to cultivated crops on many farms, owing to its tenacity and rapid growth.

Most farmers have a small orchard, mainly of peach trees, with some plums, apricots, and pears. These are grown for home use, though in a few of the larger orchards enough fruit is produced in some years to afford a surplus for sale locally. There are several commercial peach orchards in the northeastern part of the county. Fruit is often damaged by late frosts and freezes, and some years the crop is a complete failure. A fair crop of fruit is obtained on an average of about three years out of five. Plums are a more certain crop than peaches. Many of the small orchards are well kept; others are neglected and suffer from various diseases and parasites. The Mamie Ross is said to be the most successful peach, but the Elberta, Early Wheeler, Lane, and Alexander are also grown successfully. The Shiloh is considered a peach of exceptionally good flavor. The Gonzales is said to be the most successful plum, and the Kieffer and Garber are considered the best varieties of pears. Very few apple trees are seen, and few of these have a vigorous appearance.

Vegetables are grown commercially only near the towns. Considerable market gardening is carried on near Wichita Falls. Most farmers have small home gardens, often watered on a small scale from wells. The commercial gardens and small orchards around Wichita Falls are sometimes watered from Lake Wichita, and with such

treatment good yields of nearly all vegetables are obtained. The vegetables are sold locally in the towns and in the oil fields, and only small quantities are shipped out of the county. In fact, the local markets import far greater quantities of vegetables from all over the country than are produced locally. The principal vegetables grown are spinach, turnips, sweet peppers, green onions, okra, cabbage, tomatoes, mustard, beans, sweet potatoes, and peas. Potatoes are grown to a small extent.

Watermelons do well on the sandy soils and are grown by some farmers for the local markets. Tom Watson, Halbert Honey, and Kleckley Sweet are the leading varieties. Cantaloupes are grown for local use, the Rocky Ford being the most successful. Some small fields of sugar beets have yielded well and produced fine beets where moisture conditions were favorable. Berries and grapes can be grown successfully under irrigation.

Wild pecan trees are abundant and thrifty on some of the alluvial soils of the county. There seems to be no reason why pecan orchards would not be successful on such lands if proper care were used in getting the trees started.

The livestock industry consists chiefly of the raising of beef cattle on ranches. The largest areas of ranch land are in the western and southwestern parts of the county. The original large ranches have dwindled, the largest remaining comprising only about 30,000 acres. The ranch cattle are for the most part high-grade Herefords. They are grazed the year round on the native grasses, and it is estimated that in very good seasons the land will support, on the average, about one animal to 10 acres. In dry seasons much more land is required. Occasionally, if the range is short, cottonseed cake or forage is fed during part of the winter. The cattle, at the age of about 1 year, are shipped, mostly as stockers, to the Fort Worth stockyards.

Dairying is carried on near the towns of the county to supply local demands for milk. A creamery located at Wichita Falls and one at Electra are furnished milk by a number of farmers. Many farmers churn a small quantity of butter, which is sold locally. Most of the dairy cattle in the county are grade Jerseys. Apparently dairying could be increased considerably to supply various markets outside the county. It seems that under irrigation large quantities of feeds for dairy cattle could be raised and an important dairy industry developed.

Poultry and eggs, which are produced on most farms, are marketed mostly in the local markets, though some are shipped outside the county. Many farmers have flocks of purebred chickens, the leading breeds being White Leghorn, Rhode Island Red, and Barred Plymouth Rock. Some large flocks of turkeys are raised rather successfully.

Most farmers raise a few hogs for home use and for local markets, and a few are shipped to Fort Worth packing houses. The Poland China predominates in some parts of the county, but there are also a rather large number of Duroc-Jersey. Small flocks of sheep are raised for wool and for mutton, which is sold in the local markets. As a rule sheep raising is rather profitable.

Although the farmers recognize the differences between the soils, about the same crops are grown and the same general methods of

farming practiced on all the soils of the county. The great problem in farming operations is soil-moisture conditions. When the rainfall is sufficient, good or fair yields of all crops are obtained on most of the soils. If droughty conditions prevail, yields are low on most of the soils, but it is recognized that yields are far better on some soils than on others. Small grains are grown on heavy soils and on fine sandy loams, but in very dry seasons the yields are somewhat better on certain sandy soils. With considerable rain the plants grow too rank on some of the heavy bottom-land soils. It is understood that the heavier soils are generally the most productive when moisture conditions are just right, but that in very dry seasons crops may fail entirely on them or may produce very low yields, whereas the yields may be fair on the fine sandy loams. The farmers realize that Enterprise very fine sandy loam, Enterprise loamy very fine sand, and Portland very fine sandy loam return more uniform yields of corn than do other soils of the county, and that the soils of the Foard and Calumet series are better suited to small grains than to many other crops. The general adaptability of Wichita very fine sandy loam, Enterprise very fine sandy loam, and Enterprise loam, the special value of Wichita very fine sandy loam and Enterprise loamy very fine sand for fruits and vegetables, and the value of the Miller and Yahola soils for cotton and most other crops are fully recognized.

The preparation and cultivation of the land are much the same all over the county, but some special treatment is required for unusual soil and moisture conditions. The land for wheat, oats, barley, or other small grains is plowed in the summer just after harvest, if moisture conditions are favorable, or if it is then too dry it is plowed later in the summer after rains. The land is flat broken from 3 to 4½ inches deep, either with disk plows or regular moldboard turning plows, some of which have several plows on a frame. These plows are called California plows. The land is usually harrowed after each rain to prevent crusting of the soil and to pulverize it to prevent evaporation. Land for row crops, which consist mainly of cotton, corn, and grain sorghums, is usually bedded in fall or winter with listers which make furrows 1 foot or more below the crest of the intervening ridges. At planting time the land is rebedded by running a lister down the ridges, making the new furrows there and the ridges where the old furrows were. Seed is planted at the bottom of the new furrow, often at the same time that the land is rebedded. This method enables the seed to be planted in the moist soil. At each cultivation soil is thrown around the roots of the plants, until at the last cultivation the surface is left almost level or very slightly higher around the plants than in the middles. Row crops are cultivated three or four times and cotton sometimes more often. The young plants are cultivated with a "go-devil," a kind of cultivator with flat metal wings that keep the soil from going over the young plants as it is thrown into the furrow. Some farmers flat break the land before listing it for row crops. In the case of the very sandy soils of the Enterprise series, in the northern part of the county, the land is not flat broken but is left as rough as possible to prevent blowing. The land is prepared by listing, and the furrows are run east and west, or at right angles to the prevailing winds, to prevent drifting. It is sometimes necessary to replant crops two or three times where the

loose sands blow about so hard as to destroy young plants. No definite crop rotations are used, though a few farmers practice a systematic rotation of cotton and small grains. Crops are changed from time to time, and some farmers allow small-grain land to lie fallow 1 year out of every 3 to 5. Many farmers plant small grains or cotton for years on the same land with no change.

Though small, the farm buildings are in many places fairly good. As a rule, the best farm homes and buildings are found in the northern part of the county and along the uplands bordering Wichita River across the southern part of the county. Most of the barns are only large enough to shelter the work animals and a small quantity of feed. The work animals are mainly horses and mules of medium draft, which are raised locally. Most of the farm machinery is very good, and improved labor-saving implements are in common use. Many wheat farmers use small tractors, and threshing outfits travel from farm to farm.

The labor on farms is chiefly white. It is rather scarce and often is not very efficient. The farmer who hires labor has to compete with the oil fields, where labor commands a high wage. The day laborer is paid from $1.50 to $2 with board, or about $40 a month with board. Cotton is picked at a cost of about $1 a hundred pounds. Most of the farm work is done by the farmer and his family, very little labor being hired except during a short time in spring and during the harvest season.

Most of the farms are from 160 to 320 acres in size, though a few are considerably larger. The census for 1920 gives the average size of farms as 411.9 acres, with an average of 199.6 acres of improved land. The reported large average size of farms probably results from classing some of the large ranch-land holdings as farms.

More than 70 per cent of the farms in the county are operated by tenants and managers. Many tenants drift about and change places every year; others remain on the same farm for a number of years. Most of the farms are rented on the share basis, the owner receiving one-fourth of the wheat or cotton and one-third of the corn and grain sorghums. Where the landowner furnishes tools, work animals, feed, and seed, he receives one-half of all the crops.

Land prices vary widely, largely because of the discovery of oil in various sections of the county. At present much land formerly farmed is owned or leased by oil companies, and in many places the farmer has moved away. The land controlled by the oil companies may be rented but receives scant attention, being farmed very indifferently by men who spend a considerable part of their time at some kind of work in the oil fields. Where tests for oil have been unsuccessful and leases have been allowed to lapse, the land is held with the hope of again being exploited or tested. Therefore a large area of the land is not for sale. Some of the agricultural land in the northern part of the county sells at prices ranging from $50 to $125 an acre; through the central part of the county, from east to west, land values are somewhat lower; and in the southern part current values for a great deal of the land are from $75 to $150 an acre. These prices do not apply to the oil districts and do not take oil into consideration. In the Wichita River Valley and south to the county line the irrigation districts include the greater part of the

land, and here farm prices are somewhat higher than they were a year or two ago. These lands are priced from $75 to $200 an acre, depending largely on the location, the position of the land, the kind of soil, and the distance to railroads and towns.

No systematic methods are employed by the farmers to maintain or increase the productiveness of the soils. The use of commercial fertilizers is in the experimental stage. Very few farmers use barnyard manure, though results in individual cases indicate that it is a valuable addition to many of the soils. Crops are not grown in rotations that would lessen the drain on the soil by exhaustive farming. The soil has been farmed for a comparatively short time, and doubtless during dry seasons when yields are light it is enabled to recuperate considerably. This is evidenced by the testimony of farmers who say that crop yields are usually better after a very dry year.

SOILS

Wichita County lies in the Red Plains division of the Great Plains region. The underlying rocks, which have been designated as the "Red Beds," consist of fine-grained sandstones, mudstones, more or less indurated clay, and clay shales, the predominant color of which is brownish red. Strata are of varying colors, some being yellowish. In places, thick deposits of the old water-laid sediments, derived in part from soils formed from the regional rocks, cover the basal beds; in others, recent deposits have washed over low areas from higher ones. Strips of wind-blown materials also occur along the bluffs of the larger streams. The climate, which varies from moderately dry to semiarid, erosion, and vegetation have effected important changes in these soil-forming materials, by processes which have operated through long periods in the development of the existing soils. The character of the original residual and alluvial material has had much to do with the stage reached by weathering processes, as exemplified in the results of retarded drainage in impervious clay derived from the finer-textured parent material and the heavier water-laid deposits. The texture and, in some cases the color of the parent material have impressed themselves strongly on some of the derivative soils. In places imperfect drainage has contributed to the development of dark colors through its effect on the accumulating organic matter, not only by reason of the imperviousness of the material but also by reason of topographic barriers to good drainage.

The rainfall of Wichita County varies widely, ranging from about 12 to 47 inches. On the basis of average precipitation the region is subhumid, but actually there are years and successions of years characterized by the low rainfall of the semiarid regions, followed by years of the higher rainfall of humid regions. In other words, the climate is that of a gradational zone from humid to semiarid, actually including both types in the seasonal range. This has resulted in the development of soils whose physical characteristics partake of the characteristics of the soils of both the humid and the semiarid regions, but whose dominant characteristics are more like those of semiarid soils.

The mature soils contain very little lime carbonate in the topsoil, but small quantities have accumulated in the lower part of the subsoil.

Good yields of grain crops, where the moisture supply is sufficient, show that surface soils are in general well supplied with plant-food elements. The range in the soils is from youth to maturity, depending to a considerable degree on the relief and the character of the parent material. The low-lying alluvial soils are of extreme youth. They receive fresh accumulations or deposits periodically from overflows and are calcareous from the surface down, without zones of lime-carbonate accumulation. The color of the mature soils is dark, ranging in places to reddish owing to the influence of the parent material.

The mature soils of the county have three distinct layers above the substratum. The upper layer, which is 8 or 10 inches thick, consists of very dark chocolate-brown or chocolate-brown soil. The second layer, continuing to a depth ranging from 18 to 24 inches, is dark-brown clay, very hard and tough when dry, plastic when moist, and very sticky when wet. This contains no lime carbonate, as is indicated by the hydrochloric-acid test. The lower part of the subsoil, which continues to a depth of several feet, consists of lighter chocolate-brown clay of columnar or fine fragmental (cloddy) structure when dry. This is the zone of lime accumulation. Lime is present partly in the form of small concretions embedded in the calcareous clay. It appears that although the climate has favored the accumulation of lime carbonate in the subsoil of the older upland soils, the recurrence of rainy seasons has prevented, by leaching, sufficient concentration for the formation of true caliche layers. Occasional thin layers of concentrated accumulation of lime carbonate seen in deep cuts indicate an increasing development of such a layer in the western part of the county.

The greater part of the county is rolling, and on some of the more sloping areas erosion proceeds nearly as fast as the underlying formations weather and form soil. Therefore the larger part of the county is covered by young or only moderately mature soils in which the climatic influence is not as yet fully manifest, for these soils lack the black topsoil and well-developed bed of lime carbonate accumulation which are found in the mature soils of flat or very gently sloping areas.

Slick spots, locally called "alkali spots," are of common occurrence in Wichita County. They are found in soils having stiff clay subsoils, that is, subsoils resembling claypan. Some of their most conspicuous characteristics are: (1) The shallowness of the surface soil; (2) the marked toughness of the heavy clay immediately beneath the thin surface covering; (3) the presence in this clay, to a depth ranging from 15 to 30 inches, of whitish, fine crystalline material having the taste of sodium chloride; (4) the presence of small, black, round concretions and of irregular white lime-carbonate concretions below a depth ranging from 15 to 30 inches; and (5) the somewhat lighter color of the heavy clay below a depth ranging from about 24 to 40 inches. When cultivated, crops on such soil either fail completely or give very poor yields. Some virgin areas are covered with grass and weeds but, in most perfectly developed areas, vegetation is often sparse or lacking.

The Foard soils represent weathered red beds clays in which strata of sandstone occur. They are well-matured soils and show most com-

pletely the effect of the climatic conditions, having all the characteristic chemical and physical features that would be produced under conditions giving rise to mature soils. These soils have chocolate-brown topsoils, with tough, heavy subsoils which, at a depth ranging from 18 to 24 inches, become calcareous, lighter in color, and more friable, and which contain some lime concretions in the lower part. The lighter-colored clay continues to bedrock. The color of the surface soils becomes lighter as the proportion of sand increases. These soils, and especially Foard very fine sandy loam, are characterized by small, bare "alkali spots." On these spots the usual sandy cover is very shallow or entirely lacking. There is no native vegetation, and crops, except in very wet years, either make little growth or fail entirely. The lime concretions come to the surface, and a white, powdery substance having a salty taste occurs on the surface in places and is found in particles throughout the soil.

Associated with the Foard soils are the Vernon soils, which occur on the rolling upland areas. These have chocolate-red or reddish-brown topsoils and chocolate-red subsoils. They have been formed by the weathering of the red beds under conditions of good drainage and fairly complete oxidation. In many places the unweathered red beds with associated thin strata of fine-grained sandstone lie within 3 feet of the surface. This is not true on gentle slopes, however. The Vernon soils are immature and are, in many places, washed away before climatic influences produce a zone of lime accumulation. "Alkali spots" are also found on Vernon very fine sandy loam, and some of the very gently sloping areas have a calcareous lower subsoil layer containing lime concretions.

The Fowlkes soils are similar to the Vernon and Foard in origin of material and in being derived from the regional rocks of the red beds. They have chocolate-brown or brownish-red topsoils with dull reddish-brown tough heavy clay subsoils (clay pan), which grade in texture downward into less tough brownish-red clay somewhat like the subsoil of the Vernon soils. This is slightly calcareous and contains some lime carbonate concretions. The topsoil and upper subsoil material does not effervesce with hydrochloric acid. The Fowlkes soils differ from the Vernon in that the subsoils are much tougher. The tough clay in exposures cracks as does "joint clay" and forms very hard fragments. As a rule the surface of areas of the Fowlkes soils is slightly less rolling than that of areas of the Vernon, and the soils are more nearly mature.

The Calumet soils have brown or dark chocolate-brown topsoils, underlain by chocolate-brown or dark chocolate-brown stiff, heavy clay subsoils which, at a depth ranging from 18 to 30 inches, may grade into light chocolate-brown, salmon-colored, or yellowish-brown stiff clay containing some white lime concretions and some small black concretions. The topsoil and upper part of the subsoil are commonly so poor in lime carbonate as not to effervesce with hydrochloric acid, and in many places no effervescence is noted to a depth of 3 feet. In places beds of gravel, many cemented with lime carbonate, occur in the substratum. The subsoil, on drying, cracks like "joint clay" and has a hard, fragmental or cloddy structure. These soils occur on stream terraces, and a considerable part of all the material has been washed from soils derived from the Red Beds.

They are associated with Wichita very fine sandy loam but are more poorly drained. The soils of the Calumet series are mature and apparently are typical of ultimate climatic influences. Some "alkali spots" occur, but they seem to be less numerous than in areas of the Foard soils.

The Wichita soils are associated with the Calumet on flat old-alluvial terraces and occur on gentle slopes and in positions favoring somewhat better drainage. They have chocolate-brown or reddish-brown topsoils and brownish-red friable or moderately friable subsoils. Commonly neither the topsoil nor subsoil effervesces with hydrochloric acid, but in places the material of a lighter brownish-red lower subsoil layer does effervesce with acid. Gravel and beds of gravel cemented with lime carbonate occur in the substratum. These soils occur on stream terraces where part or all of the material has been washed from soils derived from the Red Beds.

The Enterprise soils are chocolate-brown or reddish-brown friable soils which do not change downwardly appreciably to a depth of many feet, except that the subsoil is commonly somewhat heavier than the soil above. They are young soils composed of material of wind-blown origin. The parent aeolian beds consisted largely of material blown off the bed of Red River at low-water stage. The component material consists mainly of silt and very fine sand. Near the bluff overlooking the river, the surface soil and subsoil are calcareous, owing to the more recent deposits of the calcareous sands and silt, but at short distances from the bluffs field tests show no free lime carbonate to a depth of 3 feet, although some may be present below this depth. This soil is constantly receiving very slight quantities of fresh soil material carried by the winds blowing from the north. The rainfall appears to be sufficient to keep the lime washed down through the soil in most places. The immaturity of the soils is evidenced by the lack of a marked difference in profile features between the surface soil and subsoil, as well as by the absence of a well-defined zone of lime accumulation.

The soils of the Miller series have brownish-red or reddish-brown topsoils underlain by brownish-red subsoils. The subsoils are typically as heavy as or heavier than the surface soils. These are alluvial soils which occur extensively along Wichita River. They are composed partly or entirely of sediments washed from the soils of the Red Plains and receive fresh deposits from periodic overflows. The fresher sediments have a very red color, but on the higher benches that are not frequently inundated, the surface color is duller red, approximating chocolate brown. These soils are calcareous from the surface down.

The Yahola soils also occur extensively along Wichita River and to some extent along Red River. Their topsoils resemble those of the Miller series, but the lower part of the subsoils is lighter in texture than are the topsoils or upper subsoil layers. The topsoil is brownish red or reddish brown, and the subsoil is brownish red. The soils of this series are strongly calcareous from the surface down. As in the Miller soils, fresh materials are being deposited over the surface by periodic overflows. As a rule, the soils of the Miller series occur largely on the more elevated areas of the river bottoms and those of the Yahola series in the lower positions.

The topsoils of the Portland soils are chocolate brown, and the subsoils are light chocolate brown or reddish brown. In many places, the lower part of the subsoil is lighter in texture than the upper part. Commonly neither topsoil nor subsoil effervesces with hydrochloric acid. The Portland are first-bottom soils, the material of which has been derived in part or wholly from soils which have been formed from the Red Beds east of the Great Plains region.

In the following pages of this report the soils are described in detail and their agricultural importance is discussed; their location is shown on the accompanying soil map; and their acreage and proportionate extent are given in Table 4.

TABLE 4.—*Acreage and proportionate extent of soils mapped in Wichita County, Tex.*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Miller silty clay loam	15,872	3.9	Calumet silty clay loam	1,728	0.4
Miller very fine sandy loam	3,968	1.0	Foard very fine sandy loam	63,552	15.5
Miller clay	3,008	.7	Foard clay loam	21,184	5.1
Wichita very fine sandy loam	8,256		Foard clay	832	.2
Rolling phase	18,176	7.1	Vernon very fine sandy loam	38,912	9.5
Heavy-subsoil phase	2,816		Vernon clay loam	62,720	15.2
Wichita fine sandy loam	3,072	.7	Vernon clay	832	
Wichita clay loam, slope phase	448	.1	Eroded phase	1,600	.6
Wichita gravelly loam	1,664	.4	Fowlkes very fine sandy loam	3,328	.8
Yahola very fine sandy loam	13,184	3.2	Fowlkes clay loam	1,088	.3
Yahola silty clay loam	2,496	.6	Portland very fine sandy loam	10,880	2.6
Yahola loamy very fine sand	8,896	2.2	Portland clay loam	8,064	2.0
Yahola loamy fine sand	2,432	.6	River wash	11,776	2.9
Enterprise loamy very fine sand	22,144	5.8	Dune sand	5,440	1.3
Dune phase	1,472		Rough broken land	12,544	3.0
Enterprise loam	4,224	1.0	Rough stony land	2,112	.5
Enterprise very fine sandy loam	22,144	5.4			
Calumet very fine sandy loam	30,656	7.4	Total	411,520	

MILLER SILTY CLAY LOAM

The surface soil of Miller silty clay loam is brownish-red or reddish-brown silty clay loam about 10 inches thick. The subsoil, to a depth of 36 or more inches, is rather heavy brownish-red silty clay. Beds of light brownish-red very fine sandy loam or loamy very fine sand occur in places from 4 to 6 feet below the surface, but in many places the clay continues to a depth of 10 or 15 feet without important change. Both topsoil and subsoil are strongly calcareous. In some inextensive areas the topsoil is rather dark and does not effervesce with hydrochloric acid, indicating a low percentage of lime carbonate. When dry the surface bakes somewhat in uncultivated fields, but when cultivated at the proper time the soil is easily kept in good tilth. After rains in warm or hot weather the soil crusts over to some extent. It is said that this crusting sometimes prevents the sprouting of seed and necessitates replanting to get good stands.

Miller silty clay loam is a rather extensive soil. It covers large areas, mostly on the high river-bottom benches in many parts of southern Wichita County, occurring usually in positions farthest from the river and adjoining the uplands or higher terraces. A very large area north and northeast of Wichita Falls, on the north side of the river, extends for several miles from the east county line

to a point south of Pleasant Valley School. Here the soil is intimately associated with the other soils of the Miller and Yahola series. A number of areas are on both sides of the river between Wichita Falls and the western border of the county. The soil extends along some of the small stream bottoms back from their confluence with Wichita River, especially near the western border of the county.

The surface of areas of Miller silty clay loam is nearly flat, with a very gentle incline toward the tributary creeks which flow across the river bottom. Surface drainage is fairly good, and the land lies in a position suitable for the application and distribution of irrigation water. Drainage on some low areas is slow, but as a rule this is not a serious matter on account of the low rainfall. The greater part of the soil is above overflow, though some small areas on the low bottoms may be inundated occasionally by high river water, and some are subject to slight overflows from the creeks which flow through the bottom lands.

Probably not less than 90 per cent of this soil is in cultivation. On the higher benches the uncleared areas support a native growth of small mesquite trees and grasses, mainly buffalo grass. In the lower bottoms near the river some spots are wooded with cottonwood, elm, ash, hackberry, chittam, and haw trees, and fine pecan trees grow rather thickly in some places. The soil is highly valued by farmers, and all of the general crops of the region are grown successfully.

The leading crops are cotton, wheat, oats, grain sorghums, corn, and sorgo. Various other crops, such as millet and Sudan grass, are grown to a smaller extent, and in places considerable Johnson grass is grown for hay. As on all the other soils of the county, the yields depend largely on the amount of rainfall. However, the areas are so smooth and flat that the soil collects and absorbs most of the rain water. Thus if there has been a good rainfall during the fall and winter the ground is well supplied with moisture, and even when the succeeding growing season is very dry the crops do very well. During the most favorable seasons the best areas—that is, soil which has not been too exhaustively farmed during a long period—produce very good yields. Cotton then yields from one-half to 1 bale to the acre, corn from 20 to 30 bushels, wheat from 20 to 30 bushels, oats from 30 to 60 bushels, and grain sorghums from 30 to 40 bushels. Sorgo yields as much as 3 or 4 tons of forage, and Sudan grass, cut twice in a season, produces from 1 to 3 tons to the acre for the season, in addition to the grazing it affords. Johnson grass, cut two or three times a year in favorable seasons, produces about 1 ton to the acre to the cutting. The average yields of crops throughout a long period, however, are very much lower than the ones quoted. Very little alfalfa has been successfully grown. Dry weather and root rot have prevented the extension of this valuable crop. Doubtless the soil is well suited to it and to sweet clover, which should prove successful under irrigation. The soil is well suited to the general farm crops, but is rather heavy for fruits and vegetables, though it is probable that with care some of these products could be grown successfully. The soil is well suited to dairy farming and livestock raising because of its ability to produce high yields of feed crops.

Selling prices of this land range from $75 to $200 an acre in favorable locations. Some areas lie near towns and railroads. The price has increased during the last two years, owing to the promise of irrigation in the near future.

Some of the land which has been farmed for many years to wheat and oats is somewhat impoverished. The humus supply has been partly depleted, and organic matter should be plowed under to restore this valuable material and to reduce the tendency of the soil to crust and bake after rains.

MILLER VERY FINE SANDY LOAM

Miller very fine sandy loam consists of brownish-red or reddish-brown very fine sandy loam underlain, at a depth of about 10 inches, by light brownish-red heavy very fine sandy loam which grades below into dark brownish-red silty clay. In places, the subsoil between a depth of about 10 and 36 or more inches is brownish-red clay or silty clay loam. Both topsoil and subsoil are calcareous. This soil in some situations has a better-developed profile than in others. On the high benches where the land has not been inundated for many years it is rather darker than in the lower areas near the river, and in places small lime concretions have formed in the subsoil. Some included areas are loamy in texture.

This soil occurs in a few fair-sized areas in the Wichita bottoms in the southern part of the county. One of the largest areas is 8 miles southwest of Iowa Park, on the south side of the river.

The surface of this soil is flat, with a gentle slope toward the river. Drainage is fairly good, and the land is well suited topographically for the application of irrigation water.

The main crops are cotton, corn, wheat, and oats. The yields are very good in favorable seasons, and crops withstand dry weather fairly well. Wheat yields from 15 to 25 bushels to the acre in the most favorable seasons and oats from 30 to 50 bushels.

Some of this soil is held at a high figure on account of its proximity to oil fields. For agricultural purposes, it has about the same value as Miller silty clay loam.

MILLER CLAY

Miller clay, to a depth of about 12 inches, is brownish-red silty clay. This material is underlain by heavy silty clay of the same color which continues to a depth of 36 or more inches. In places, the material below a depth of 4 or 5 feet is very fine sand or very fine sandy loam. Both topsoil and subsoil are calcareous. The soil bakes on drying, but with proper cultivation a fairly good tilth can be maintained. The surface crusts over after rains in such a way as to retard the development of sprouting plants, sometimes causing poor stands.

Miller clay occurs in many small areas in the southern part of the county, in the Wichita River bottoms, commonly in association with Miller silty clay loam. The areas are widely separated in many parts of the river bottoms. One of the largest is about 3 miles northeast of Wichita Falls.

This soil occurs on both the high and the low bottom-land benches in rather low, flat positions. Most areas are slightly depressed below the surface of the surrounding soils. In many of the old river channels water accumulated in rainy seasons forms lakes which may exist for several months. Many areas, however, are sufficiently well situated to allow fair drainage and cultivation, though in a region of greater rainfall it would be necessary to establish some artificial drainage for crop production. Under irrigation, water can be placed on this soil rather readily, but for best results better drainage should be provided.

Only about 20 per cent of this soil is in cultivation. The crops grown and the yields obtained are about the same as on Miller silty clay loam. The soil is well suited to cotton, corn, wheat, oats, grain sorghums, and forage crops. Probably alfalfa and sweet clover would succeed under favorable drainage conditions. Owing to its comparative heaviness and difficulty of cultivation the soil is not favorably considered by some farmers, although it is recognized as productive.

WICHITA VERY FINE SANDY LOAM

Wichita very fine sandy loam consists of choclate-brown, reddish-brown, or brownish-red very fine sandy loam underlain, at a depth ranging from 6 to 12 inches, by brownish-red or reddish-brown rather heavy clay which becomes lighter in color with depth and grades, at a depth ranging from 16 to 26 inches, into light brownish-red, friable clay. As a rule, neither topsoil nor subsoil showed the presence of lime carbonate by field test, although in places the lower subsoil material effervesces slightly with acid and contains a few small lime concretions. In long periods of dry, hot weather the soil hardens in uncultivated fields. A good tilth is easily maintained by cultivation. The upper part of the subsoil becomes very hard in dry weather and breaks with blows into small fragments. The lower subsoil material does not become so hard, owing perhaps to better moisture conditions. The subsoil is not so impenetrable but that water passes downward rather readily. Beds of smooth, rounded, small quartz gravel occur several feet below the surface. These are cemented by the lime carbonate in places into layers of "concrete" or conglomerate 1 foot or more thick. Associated with the gravel is a mixture of sand containing considerable lime carbonate.

Wichita very fine sandy loam occurs in a number of areas throughout the eastern and southern parts of Wichita County, in the vicinity of Wichita River, and along Red River. It occupies flat terraces adjacent to the Miller and Yahola soils and in many places is associated with the Calumet soils. The soil occurs in the better positions on the terraces, whereas the Calumet soils cover the most poorly drained areas.

Areas of this soil are nearly flat or gently undulating and most slopes are very gentle. Drainage is very good, as a rule. Some of the gentle slopes have been washed slightly, causing the surface soil to be somewhat shallow. Most of the soil is favorably situated for the application of irrigation water.

Wichita very fine sandy loam is recognized by farmers as a very good agricultural soil, fairly productive, easily cultivated, and suit-

able for the production of a number of crops. Probably 75 per cent of it is in cultivation, and the remainder, utilized for pasture, comprises a more or less open prairie covered with grasses indigenous to the region. Of these grama, needle, and buffalo grasses are the most important. Scattered small mesquites constitute the only tree growth. The crops grown are cotton, corn, grain sorghums, sorgo, wheat, oats, and some fruits and vegetables. The chief crops are cotton, forage crops, and grain sorghums. The soil appears rather light for the small grains. In seasons of adequate rainfall the yields of all crops are very good. Cotton produces, under favorable conditions, from one-half to three-fourths bale to the acre, corn from 20 to 30 bushels, wheat from 12 to 15 bushels, oats from 30 to 40 bushels, and grain sorghums 30 bushels. During dry seasons all crop yields are much less. Cotton, the grain sorghums, and sorgo are apparently the most drought-resistant crops on this soil. The soil is well suited to fruits, berries, and vegetables, and many are produced commercially near Wichita Falls. Some of these products have been produced commercially for a number of years by means of irrigation from Lake Wichita, the city water reservoir. The leading fruits are peaches, plums, and pears. The soil responds well to applications of barnyard manure and to other fertilizing practices, such as the plowing under of organic matter and the growing of legumes. Some cotton and corn have been grown very successfully near Wichita Falls on small areas that have been irrigated from Lake Wichita.

Areas of Wichita very fine sandy loam occurring near towns are held at a rather high figure, especially in the truck-farming district where irrigation has been possible. Here the values of the small improved truck farms range from $250 to $500 an acre. The outlying areas utilized for dry farming have sold for $75 or $100 an acre, though some, in especially favored localities, bring from $150 to $200 an acre. The price of the land has increased somewhat with the development of the large irrigation project, as much of the soil lies within the district that will be subject to irrigation. Plenty of organic matter should be plowed under to maintain the humus content.

Wichita very fine sandy loam, rolling phase.—The topsoil of Wichita very fine sandy loam, rolling phase, is brownish-red or reddish-brown very fine sandy loam about 10 or 12 inches thick. This grades in texture through heavy very fine sandy loam about 1 or 2 inches thick into rather heavy, brownish-red sandy clay which, at a depth ranging from 18 to 24 inches, becomes lighter in color and continues to a depth of 36 or more inches. In places, the subsoil is heavy very fine sandy loam to a depth of 18 inches and below that is clay loam. Beds of waterworn gravel several feet thick occur at various depths. On the more nearly level areas the gravel is from 4 to 10 feet below the surface, though in many places it is only 1 or 2 feet below. Locally it is very near the surface. The beds of gravel vary in thickness from 1 to 5 feet and rest on "Red Beds" clays. In many places, much of the gravel is cemented into "concrete" or conglomerate, the binding agency being lime carbonate. In some areas the lower subsoil material is calcareous and contains small lime concretions, though as a rule the field test reveals no lime carbonate in either topsoil or subsoil.

The principal areas of Wichita very fine sandy loam, rolling phase, occur on the high upland just north of the Wichita River Valley, and a number of areas are south of the Red River Valley. Some of the larger areas are a few miles northeast of Wichita Falls, and a large body occurs on the crest of a broad ridge around Cashion School, in the northeastern part of the county.

The surface of the land varies from gently rolling or undulating to rolling. The drainage is very good throughout. Erosion has removed the greater part of the soil in some areas, and the underlying red beds are exposed on many of the steeper slopes. Thus the soil, as mapped, includes small areas of Vernon very fine sandy loam and Vernon clay loam that have been formed by the weathering of exposed red beds.

On typical Wichita very fine sandy loam, good water is obtained from wells about 20 or 25 feet deep, whereas, on areas of the rolling phase the sediments are so thin that wells penetrate the red beds at a slight depth, and little or no water is obtained as a rule.

Probably not more than 40 per cent of this soil is under cultivation. Most of it remains covered with the native prairie grass and is utilized for pasture land. The grasses consist of buffalo grass, *Hordeum pillosum*, a very early grass, needle grass, and where the structure is loose considerable sedge grass (*Andropogon*, sp.). Areas in which the soil is several feet deep over the red beds are rather productive, and good yields of various crops are obtained when the rainfall is adequate. About the same crops are grown, with approximately the same yields, as on the typical soil. On the shallow beds, the soil is only moderately productive. Although the soil of this phase is of comparatively small extent in the county, it is, where most advantageously situated, a desirable soil for cotton, grain sorghums, fruits, and vegetables. It sells, with more extensive associated soils, at prices ranging from $50 to $100 an acre. In a few places, the underlying gravel beds are worked, the gravel being very valuable for road-building and other building purposes.

Wichita very fine sandy loam, heavy-subsoil phase.—Practically the only difference between this soil and typical Wichita very fine sandy loam is that this has a heavy, tough subsoil, whereas the subsoil of the typical soil is friable. This soil occurs in close association with typical Wichita very fine sandy loam and Calumet very fine sandy loam, on the low terraces in the vicinity of Wichita Falls and a few miles southwest of that place.

The surface is commonly nearly flat or very gently sloping. The surface drainage is slow, and the passage of water downward through the soil mass is also slow.

Probably 75 per cent of this soil is in cultivation, the remainder being covered with native grasses and a scattering of small mesquite trees. The same vegetation grows on this soil as on typical Wichita very fine sandy loam. The soil is rather productive. The crops grown are cotton, wheat, oats, grain sorghums, and some fruits and vegetables. When moisture conditions are favorable, good yields are obtained. Some of the soil near Wichita Falls is irrigated, the water being obtained from the city reservoir, and is used for the production of vegetables. Vegetables, with some cotton and corn, have been produced very successfully on this soil under irrigation.

WICHITA FINE SANDY LOAM

The topsoil of Wichita fine sandy loam is chocolate-brown, reddish-brown, or brownish-red fine sandy loam or loamy fine sand from 6 to 10 inches thick. As a rule the thickness of the soil does not exceed 10 inches, but on a few gentle slopes or in depressions the topsoil may be of somewhat greater thickness. In places the texture of the topsoil is sandy loam. The subsoil is rather heavy brownish-red or reddish-brown clay or sandy clay, the color of which becomes somewhat lighter with increasing depth. At a depth ranging from 24 to 30 inches the material, in many places, is light brownish-red sandy clay, which continues to a depth of more than 3 feet. The topsoil and subsoil do not contain lime carbonate, according to field tests, though in places the lower part of the subsoil is calcareous and contains some small lime concretions. Beds of waterworn gravel occur in places several feet below the surface.

Included in mapped areas of this soil are several small areas of loamy fine sand near Burkburnett. The largest is about 2 miles southeast of that place. This differs from typical Wichita fine sandy loam in that the subsoil consists of fine sand or fine sandy loam instead of clay.

Wichita fine sandy loam occurs in a number of small areas between Iowa Park and Kemp City.

The surface of Wichita fine sandy loam is generally flat or undulating, with gentle slopes. The few areas north of the Wichita River Valley and in the vicinity of Burkburnett have rather steep slopes and are more rolling than those on the stream terraces near Wichita River. Surface drainage is usually good.

Perhaps 75 per cent of this soil is in cultivation. Where not in cultivation the land retains the original vegetation of small, scattered mesquite trees and a heavy sod of prairie grasses of which needle grass, grama grasses, and buffalo grass are the most abundant. Cotton, forage crops, grain sorghums, and small grains are the crops grown. In favorable seasons these yield well, cotton yielding about one-half bale to the acre, wheat from 12 to 15 bushels, oats from 20 to 40 bushels, and grain sorghums approximately 25 or 30 bushels. The soil is well suited to the production of peaches, plums, berries, and vegetables. The areas of lighter texture are also suited to melons, cantaloupes, and peanuts.

The land used for agricultural purposes commands between $50 and $100 an acre.

WICHITA CLAY LOAM, SLOPE PHASE

In Wichita clay loam, slope phase, the surface soil of brownish-red or reddish-brown clay loam is underlain, at a depth ranging from 3 to 8 inches, by clay of the same color. At a depth ranging from 18 to 24 inches, the material becomes a little lighter in color and more friable. The topsoil and subsoil are calcareous in places and contain lime concretions, which are more numerous in the lower than in the upper part of the subsoil. In places, the subsoil also contains small black concretions. When wet, the surface soil is somewhat sticky, and on drying it bakes into a mass of rather firmly bound small fragments. In places, a layer of fine sandy loam, 1 or 2 inches thick,

covers the surface, and in others there are small eroded spots of clay loam and clay and bare "alkali spots."

This soil is of very small extent in the county. It occurs in a number of small, narrow areas between Wichita Falls and Iowa Park, just north of the Wichita River bottoms. It occupies gentle or rather steep slopes extending downward from the flat terraces which comprise the Wichita and Calumet soils. However, none of the slopes are sufficiently steep to prevent cultivation. Surface drainage is good, and in places erosion has damaged the soil considerably by removing a large part of the valuable surface soil.

This soil lies in the irrigation districts and may be reached by gravity water from the canals. Probably 80 per cent of it is in cultivation, as it lies in a section devoted to extensive farming. The native vegetation consists of mesquite trees and the prairie grasses common to the soils of the Wichita series. The soil is cultivated in conjunction with the surrounding soils and constitutes only a small part of the farms. It is therefore difficult to obtain information as to crop yields on it. It is utilized principally for small grains, though some cotton and the grain sorghums are grown. The yield of wheat in very good seasons is about 20 or 25 bushels to the acre, and that of the grain sorghums is about 25 or 30 bushels. Cotton, under the most favorable conditions, yields about one-half bale to the acre. Owing to the sloping surface, water runs off the soil rapidly during rains, and crops may suffer in very dry seasons.

Land of this kind sells at the present time, along with the more extensive soils, at prices ranging from $100 to $150 an acre.

This soil should be cultivated in such a way as to minimize the tendency to wash after rains, both by running rows and cultivating along the contour of the slope, and by maintaining a system of terraces. Considerable organic matter should be plowed under to maintain a supply of humus in which the soil appears to be rather deficient.

WICHITA GRAVELLY LOAM

The topsoil of Wichita gravelly loam is chocolate-brown or brownish-red loam containing a large proportion of small waterworn gravel, some of which is as much as 3 inches in diameter. The subsoil is of much the same character, except that in many places the interstitial fine material is brownish-red clay, and in other places almost nothing but gravel is present. The clay red beds materials occur at a depth of less than 3 feet in many places. The gravel consists mainly of quartz and quartzite, but some black, igneous rock and limestone materials are present. In many places the gravel has been cemented into a very hard conglomerate by lime carbonate.

Mapped areas of this soil include areas of Wichita clay loam too small for separate mapping. In these areas a topsoil of brownish-red or reddish-brown clay loam 6 or 8 inches thick is underlain by a subsoil of brownish-red or reddish-brown heavy clay which, at a depth ranging from 18 to 24 inches, grades into friable, brownish-red clay somewhat lighter in color than the upper part of the subsoil. This continues to a depth of 36 inches, and in places is rather calcareous and contains small lime concretions. Beds of gravel

are several feet below the surface. Mapped areas also include areas of gravelly fine sandy loam and gravelly clay loam and clay.

This soil occurs in a few very small areas, mostly on the knobs or ridges north and south of the Wichita River Valley. Those near Iowa Park are the largest.

Wichita gravelly loam is subject to erosion. None of it is under cultivation, except a few of the small areas of included Wichita clay loam on which cotton, grain sorghums, sorgo, wheat, and oats are grown. The soil supports a rather thin growth of weeds and grasses, of which the more common are needle grass, grama grass, and one of the Andropogons. The soil has practically no value for cultivated crops, but as the gravel is valuable for road building and for other uses, these areas have considerable value for purposes not connected with farming.

YAHOLA VERY FINE SANDY LOAM

The surface soil of Yahola very fine sandy loam is brownish-red or reddish-brown very fine sandy loam underlain, at a depth ranging from 8 to 12 inches, by lighter brownish-red loamy very fine sand, which grades below into very fine or fine sand continuing downward for several feet. In many places in the subsoil there are alternate layers, several inches thick, which range in texture from very fine sandy loam to silty clay loam. As the depth approaches 3 feet, however, the material is either very fine sand or light very fine sandy loam. It is a marked characteristic of the soil that the lower part of the subsoil (in many places all of the subsoil) is of lighter texture than the surface soil. In the Red River bottoms the soil in many places is underlain at a slight depth by light or flesh-colored fine sand.

The topsoil of some included patches consists of fine sand, loamy very fine sand, or even loam, silt loam, and silty clay loam. It was impractical to show many small patches of these soils separately on a map of the scale used. Both the topsoil and subsoil are characteristically calcareous.

Yahola very fine sandy loam occurs in many large areas in the Wichita bottoms across the southern part of the county, and in a number of small areas in the Red River bottoms. This is the most extensive soil of the Yahola series and one of the most important in the county. Much of this soil is near Wichita Falls and Iowa Park.

Areas of Yahola very fine sandy loam are nearly flat, though there are numerous slight undulations, some very slightly depressed patches covering a few acres, and some very gentle swells or very low, ridge-like areas. The lower, flat areas comprise slightly heavier phases of the soil than occur in the higher areas. The slope, though gentle, is sufficient to make the soil well suited for irrigation. In the Wichita bottoms, some areas occur on the lower benches, but a very much larger proportion occurs on the high benches. In the Red River bottoms the soil is found in low, nearly flat areas.

The drainage of this soil is good. On the low benches, which are from 10 to 15 feet above the stream bed within the river bends, overflows sometimes occur in time of freshet, for there the water table

lies but a few feet below the surface. The higher benches, which are from 20 to 30 feet above the stream bed, are never inundated. Erosion of the sides of the high benches of the Wichita bottoms commonly results in caving and gives rise to water-cut banks.

Yahola very fine sandy loam is considered a very desirable soil for farming, and probably 90 per cent of it in the Wichita bottoms is in cultivation. The small areas in the Red River bottoms and some low benches along Wichita River are not cultivated. Probably 80 per cent of the total area in the county is farmed, the remainder being used for grazing. The native vegetation consists of a scattered tree growth including cottonwood, hackberry, elm, ash, chittam, pecan, and other trees. On the higher benches along Wichita River there are a few mesquite trees, but no forest growth appears on the areas in the Red River bottoms. A variety of native grasses, comprising largely coarse bunch grass (Andropogons), needle grass, and some buffalo grass, afford good grazing. Salt grass grows along some of the low areas. There is also usually a considerable growth of weeds.

The leading crops are cotton, corn, grain sorghums, wheat, oats. and sorgo, and minor crops include millet, Sudan grass, peanuts, and others. As on other soils of the county, the crop yields depend to a considerable degree on the seasons. When the rainfall is ample the yields are fairly high; during dry seasons they are correspondingly low. If the soil has a good store of moisture at the beginning of the growing season the crops will do well, but owing to the comparative porosity of the subsoil and substratum frequent showers are necessary for best results. It seems that under dry-farming conditions cotton, grain sorghum, and forage are the most certain crops. In good seasons cotton yields from one-half to three-fourths bale to the acre, grain sorghums yield 25 or 30 bushels, wheat from 15 to 25 bushels, oats from 30 to 45 bushels, and corn from 15 to 25 bushels. Wheat probably does not average more than 10 or 12 bushels to the acre. Under favorable seasonal conditions the yields of the small grains, as reported, are rather surprisingly high, considering that the soil is so light. The soil is well suited to vegetables and such fruits as peaches and plums, as well as berries, peanuts, melons, and cantaloupes. No large plantings of these special crops are grown, but some small orchards and gardens give evidence of their successful growth. Sudan grass, millet, and forage crops yield well when moisture conditions are favorable. Alfalfa and sweet clover would probably grow successfully with adequate moisture, though yields likely would not be so high as on the heavier soils of the Yahola series. Corn is a rather uncertain crop on this as well as on most other soils of the region, owing to frequent dry spring seasons, but with proper moisture conditions yields would doubtless be fairly good. Grapes would also probably succeed.

This land is held at prices ranging from $75 to $100 an acre. Prices are somewhat higher in favorable localities, but are considerably lower along Red River. Some areas in proximity to oil wells are held at higher prices, as are also those in the irrigation districts.

This soil is easily tilled and, being fairly productive and suited to a large number of crops, is valued highly. When dry and un-

protected by vegetation it blows some in heavy winds but usually does not drift sufficiently to do much damage. Large quantities of organic matter should be incorporated in the soil to supply humus and prevent blowing. Possibly where irrigation is practiced some special means should be provided to prevent seepage from ditches.

YAHOLA SILTY CLAY LOAM

The surface soil of Yahola silty clay loam is brownish-red or reddish-brown silty clay loam. It is underlain, at a depth of about 10 inches, by brownish-red silty clay, which, at a depth ranging from 15 to 24 inches, grades in texture into loamy very fine sand or very fine sandy loam. The lighter-textured lower subsoil material continues to a depth of several feet. Both topsoil and subsoil are calcareous. When dry, the soil bakes somewhat in uncultivated fields, but cultivated areas work into a highly desirable condition, which is easily maintained to a depth of 3 or more inches throughout the growing season. In the Red River bottoms the topsoil is underlain by pale brownish-red or flesh-colored fine sand, which in places is near the surface. Mapped areas of this soil include a few areas of Yahola clay and Yahola loam.

This soil is of no great extent, though it occurs in many small areas throughout the bottom lands along Wichita and Red Rivers. Comparatively large areas are northeast of Wichita Falls and northwest of Valley View School. Numerous other areas are scattered through the bottoms between Wichita Falls and the southwest corner of the county. The surface soil in the Red River bottoms is in places rather dark and in others is a powdery deposit of salty material.

Areas are flat and in places are slightly depressed, but drainage is fairly good, as the light subsoil and substratum permit fairly good underdrainage. The soil occurs on both high and low river benches. In the latter positions it is occasionally inundated.

Probably 50 per cent of this soil is cultivated. In some uncultivated areas the tree growth is rather abundant. On the lower benches the growth includes cottonwood, chittam, pecan, elm, hackberry, wild chinaberry, haw, and others. On the high benches some mesquite trees grow. The principal grass is buffalo grass. Cotton, small grains, grain sorghum, corn, and sorgo are grown. The soil is naturally very productive, and when rainfall is adequate cotton yields as much as 1 bale to the acre, wheat from 20 to 25 bushels, oats from 30 to 50 bushels, grain sorghums 30 bushels, and other crops in proportion. In dry seasons, the yields are very much lower, though the soil withstands drought fairly well. The soil is best suited to cotton, corn, small grains, and forage crops. Sudan grass gives excellent yields. Alfalfa should produce well and thrive under favorable moisture conditions. It is said that in some rather wet seasons wheat and oats grow very rank and sometimes lodge. Though a desirable soil for the general farm crops, this soil is rather heavy for the best production of fruits and vegetables which, however, may be grown. Sweet clover could, doubtless, be grown with success.

Current prices of this land range from $75 to $150 an acre in the more desirable locations within a few miles of towns.

YAHOLA LOAMY VERY FINE SAND

The surface soil of Yahola loamy very fine sand consists of light brownish-red or reddish-brown loamy very fine sand which grades, at a depth of about 8 inches, into lighter brownish-red very fine sand. At a depth ranging from 18 to 24 inches the color becomes very light brownish red and continues so to a depth of several feet. The topsoil and upper part of the subsoil contain enough silt and clay to make the material slightly coherent when moist; on drying it becomes somewhat hardened, especially in hot, dry weather. The subsoil is commonly less loamy than the topsoil and contains less silt and clay. Both topsoil and subsoil are calcareous.

Included with mapped areas of this soil are very small areas of Yahola very fine sandy loam. In the northern part of the county along Red River the subsoil is in many places pale-red or flesh-colored fine sand within a few inches of the surface.

This is a rather extensive soil in the river bottoms of the county. Many areas are along Wichita River and some are along the low, flat bottoms of Red River. The soil occurs in association with the other soils of the Yahola series, mainly with the very fine sandy loam. Though occurring as a rule along the low bottoms some areas occupy the higher benches.

Areas of this soil are almost flat, commonly with a gentle slope. In places the surface is undulating or billowy. The drainage is very good, as water passes quickly downward through the soil. Some of the soil in the bottoms of Wichita River is favorably situated for irrigation. Occasionally some of the lower land is inundated.

Probably half of the Yahola loamy very fine sand in the Wichita River bottoms is in cultivation, but very little is cultivated in the Red River bottoms. Where uncultivated, the soil in the Wichita River bottoms is partly wooded with an open growth of cottonwoods and a few other trees. Coarse weeds are abundant. Some bunch grass, bur grass, needle grass, and several other grasses grow on this soil.

The crops grown are chiefly cotton, corn, and grain sorghums, and small quantities of wheat and oats. The yields are fair even in dry seasons, if there is a good store of moisture in the subsoil and substratum at the beginning of the growing season. For best results, however, the soil requires frequent showers during the growing season. In good seasons cotton yields from one-fourth to one-half bale to the acre and corn from 15 to 20 bushels. Wheat and oats provide good grazing for livestock during the winter and spring, and if the season is favorable a small yield of grain is obtained. The soil is well suited to melons, plums, and vegetables. It has a somewhat lower productive value than Yahola very fine sandy loam, though some areas are fairly productive.

This land is sold along with associated soils of greater extent for prices ranging from $50 to $100 an acre. It probably would not bring so much if sold alone. These prices apply to the soil in the Wichita River bottoms, the land being valued considerably lower, for agricultural purposes, in the Red River bottoms.

Improvement could be brought about by applications of manure and by plowing under such crops as cowpeas. Under irrigation some difficulty might be experienced from seepage.

YAHOLA LOAMY FINE SAND

Yahola loamy fine sand consists of light brownish-red or reddish-brown loamy fine sand, about 10 inches thick, underlain by loamy fine sand or fine sand, predominantly light brownish red but in places yellowish. The fine sand is many feet thick, and the material is calcareous from the surface down. When dry, the soil immediately at the surface has a rather grayish color. It is so loose that where unprotected it blows considerably during heavy winds. Mapped areas of Yahola loamy fine sand include smaller areas of fine sand.

This soil occurs in the southern part of the county in a number of small areas in the Wichita River bottoms, mostly on the lower benches and near the river, and in the northern part in several areas along Red River. A few small unimportant patches are closely associated with Yahola very fine sandy loam on some of the higher benches.

The surface is generally flat, though slight inequalities give a billowy configuration. Drainage is very good, as water passes rapidly downward through the permeable, loose mass.

Probably not more than 20 per cent of this soil is in cultivation, the remainder being covered by the usual bottom-land growth of the region. This consists of a scattered growth including some cottonwood, pecan, and elm trees, and in most places an abundance of large weeds, and some needle, bunch, and other grasses. Crops grown are cotton, corn, grain sorghums, and sorgo. The crop yields are about the same or are slightly lower on the whole than those obtained on Yahola loamy very fine sand. The soil seems best suited to melons, forage crops, plums, blackberries, and vegetables. Possibly sweet clover could be successfully grown. If so, this would increase the value as pasture land.

ENTERPRISE LOAMY VERY FINE SAND

Enterprise loamy very fine sand is chocolate-brown or reddish-brown loamy very fine sand which in many places continues downward 3 or more feet without any appreciable change in color or texture. In some areas, the surface soil is light chocolate brown and when dry is grayish brown. In other places, it is rather reddish from the surface down. Over the greater part of its extent, the dry soil has a decidedly reddish shade, in some places being decidedly dull brownish red.

In spots nearest the Red River Valley, the topsoil and subsoil are calcareous from the surface down, whereas in other places field tests show no lime carbonate in the topsoil or subsoil. In some cuts the chocolate-brown or brownish-red loamy very fine sand is shown to be from 20 to 25 feet thick. It rests on the red beds. No "alkali spots" were seen. Flat areas in which the surface soil is somewhat darker than typical occur in the northeastern part of the county, northwest and southeast of Burkburnett. Mapped areas of Enterprise loamy very fine sand include also areas of loamy fine sand.

Enterprise loamy very fine sand is a soil of considerable extent. It occurs in a narrow, almost unbroken band across the extreme northern part of the county on the bluffs of the upland adjoining the

bottom lands of Red River and extends south from the bluffs for more than a mile in places. The surface is gently undulating or gently rolling, and the drainage is good. Good water is obtained in gravel and sand beds at a depth ranging from 16 to 25 feet.

The native vegetation of this soil consists of coarse grasses, a bunch grass being abundant.

This soil, though rather light and sandy, is considered very desirable by farmers, and probably not less than 90 per cent of it is in cultivation. It is said that crops withstand dry weather or droughty conditions extremely well on it. In dry seasons when crops make very light yields or fail on many of the heavier soils of the county, fair yields are obtained on this soil. The crops grown are cotton, grain sorghums, corn, sorgo, and some wheat and oats. Cotton, the chief cash crop, yields an average of about one-third bale to the acre, though some years three-fourths of a bale is produced. Grain sorghums yield from 20 to 25 bushels to the acre, wheat 10 or 12 bushels, and oats 25 or 30 bushels. More corn is grown on this soil than on any other upland soil in the county, and it is said to average about 20 bushels to the acre. The soil is fairly drought resistant, and the range of yields between very dry and very favorable seasons is not so great as on most of the soils of the county. The soil is rather light for wheat and oats, though some is grown with fairly good results. In places, especially where the soil is lightest, it is subject to blowing and drifting in the hard winds which are usually more prevalent during the spring months. The farmers find it best to leave the surface rough during the winter, allowing vegetation and trash to stand without being plowed under. Then furrows are run approximately east and west, or at right angles to the prevailing hard winds. The land is listed, leaving it in deep furrows and ridges, and the seed is planted in the bottom of the furrow. This practice usually suffices to prevent the drifting of the soil.

Peaches, plums, grapes, melons, cantaloupes, berries, and vegetables do well on this soil and produce good yields. In the extreme northeastern corner of the county some fairly large commercial peach orchards are rather successful. Gonzales seems to be the best variety of plum, and the Halbert Honey watermelon is the best produced. Watermelons are raised for the local markets by a number of farmers. One of the best peaches is said to be the Shiloh variety, though the Elberta, Early Wheeler, Mamie Ross, Lane, and Alexander varieties also do well. The soil is well suited to peanuts, and at times a considerable acreage is grown for hay. Farms on this soil appear successful, and the homes and improvements are as a rule fairly good.

This land sells at prices ranging from $50 to $125 an acre. A large quantity of organic matter should be added to it, not only to supply humus but to prevent blowing as much as possible. Scattered straw would prove beneficial. It is possible that sweet clover would succeed and prove a valuable crop.

Enterprise loamy very fine sand, dune phase.—The topsoil of Enterprise loamy very fine sand, dune phase, consists of light chocolate-brown or reddish-brown (in places, dark brownish-red) loamy very fine sand ranging in thickness from 6 to 18 inches. It is

underlain by loamy very fine sand of much the same texture and color as the surface soil, except that in places it is yellowish red or reddish yellow. In many places near the bluffs of Red River Valley, the topsoil and subsoil are calcareous, and here the red color predominates. Farther back from the bluff, where the topsoil and subsoil are less red there is no lime carbonate, according to field tests. Areas of loamy fine sand occur in mapped areas of this phase of soil, but these were too small to map separately.

Soil of this phase is not very extensive. It occurs in close association with the typical soil, differing from it chiefly in its dunelike appearance and in its slightly coarser texture. It commonly occurs in narrow strips immediately along the bluff areas overlooking the Red River bottom lands in the northern part of the county.

Areas of this soil are rolling and billowy. A series of dunes form ridgelike areas somewhat higher than the surrounding soils. The dunes come together for the most part, and the depressions between are sharp bottomed and narrow. Drainage is good. Owing to the rather uneven configuration caused by the dunes, together with the light structure and tendency to blow, practically none of this soil is cultivated except one fair-sized area several miles north of Freeburg. Most of the soil is covered with bunch grass, some short grasses in which needle grass is abundant, considerable sagebrush which is somewhat similar in appearance to Artemisia, and a fair growth, in places, of bear grass. Where this native vegetation is left the soil is not blown about, but in cleared and cultivated areas it drifts considerably in heavy winds. It is rather loose and incoherent, containing only a very small quantity of material finer than the finest sand.

Fair yields of grain sorghums and forage crops are obtained on this soil, which is probably not to be recommended for any other crops except perhaps plums, melons, and vegetables. For best results even with these products some form of windbreak should be used. Possibly sweet clover could be grown.

Soil of this phase has a much lower selling price than the typical soil.

ENTERPRISE LOAM

The topsoil of Enterprise loam is chocolate-brown loam about 8 or 10 inches thick. The subsoil is chocolate-brown or reddish-brown clay which, though somewhat sticky when wet, is not tough when dry. Though the topsoil nowhere shows the presence of lime by field test, the subsoil is calcareous in places and contains lime concretions. In other places the lime and concretions occur only as the depth approaches 3 feet. Below a depth varying from 3 to 5 feet is chocolate-red clay or heavy sandy clay containing lime concretions. Mapped areas of this soil include patches of clay loam and a few spots of very fine sandy loam. As a rule there are not many "alkali spots."

Enterprise loam is not an extensive soil. It occurs in a number of areas in the northwestern part of the county a few miles north of Electra. The surface varies from undulating to gently rolling, and some areas are nearly flat. Surface drainage is good, and in places slopes are sufficiently steep to allow surface wash after heavy rains.

Enterprise loam is prairie land, the native vegetation consisting mainly of buffalo and grama grasses. The soil is considered valuable by farmers, and probably 95 per cent of it is under cultivation. The crops grown are cotton, wheat, oats, sorgo, Sudan grass, grain sorghums, and some small areas of corn. In seasons of sufficient rainfall, cotton yields from one-half to three-fourths bale to the acre, wheat from 15 to 25 bushels, oats from 30 to 60 bushels, Sudan grass from 1 to 2 tons, and grain sorghums from 25 to 35 bushels. Peaches, plums, and vegetables do well in the small home gardens and orchards.

This soil is so friable that it may be tilled easily and kept in a good, loose condition in cultivated fields, although it gets rather hard in long dry seasons where it is uncultivated. Crops appear to withstand dry conditions somewhat better than on the Foard and Vernon soils. Farm homes and improvements are good and give the appearance of successful farming. Some dairy farming is conducted on this land, mostly in conjunction with general farming. Wheat and cotton are the most important crops. Much of the land appears to be farmed by rather good methods, though no fertilizers are used.

Farms on this soil bring from $75 to $125 an acre.

ENTERPRISE VERY FINE SANDY LOAM

Enterprise very fine sandy loam consists of chocolate-brown or reddish-brown very fine sandy loam, underlain at a depth varying from 10 to 15 inches by reddish-brown or dark brownish-red very fine sandy loam. Some areas have a fine sandy clay loam subsoil. As a rule the topsoil does not contain enough carbonate of lime to be detected by the ordinary methods, and in most places the same is true of the subsoil. In other places, however, the subsoil contains considerable lime carbonate, usually in the material near the 3-foot depth.

Enterprise very fine sandy loam occurs in a number of areas extending in a broken belt across the northern part of the county. It is associated with Enterprise loamy very fine sand, which it resembles considerably except in being slightly heavier.

Areas of Enterprise very fine sandy loam are flat in most places, and many are surrounded by higher-lying soils. The soil occupies high benches along the Red River bottoms and occurs on the flat or undulating upland strip along the bluffs. Drainage is good, owing to the permeableness of the topsoil and subsoil.

The native vegetation consists mainly of buffalo grass and some of the grama grasses.

Nearly all of this soil is in cultivation. The crops grown are cotton, corn, grain sorghums, wheat, oats, Sudan grass, and sorgo. Yields, especially of wheat and oats, are somewhat higher than on Enterprise loamy very fine sand. The soil is considered very desirable by farmers, as it is productive and resistant to drought. Yields are said to be fairly good even in the very dry seasons. Cotton yields as much as 1 bale to the acre, corn from 20 to 30 bushels, and wheat as much as 25 bushels. The average yields are somewhat lower than these, however. Alfalfa has been grown successfully for

several years, and several small fields were seen. Three or four cuttings annually are reported, with average yields of about 1 ton to the acre at each cutting. Small orchards of peaches and plums were seen about farm residences, and vegetables succeed in the home gardens. Good well water is obtained at a slight depth. It would seem that sweet clover could be grown successfully.

The current selling price of this land ranges from $100 to $125 an acre.

CALUMET VERY FINE SANDY LOAM

The surface soil of Calumet very fine sandy loam is brown or chocolate-brown very fine sandy loam underlain, at a depth ranging from 4 to 8 inches, by the subsoil of tough, heavy clay varying in color from very dark chocolate brown to chocolate brown and in places to reddish brown. This clay grades into clay of lighter color at a depth ranging from 18 to 24 inches and continues to a depth of more than 36 inches. This lower subsoil material is commonly calcareous and contains lime concretions. A few fine black concretions are found in the topsoil and subsoil. On a freshly tilled, dry field small spots of dark-grayish soil are observed in slight depressions where water stands longer than elsewhere. These spots have very dark-brown topsoils and subsoils which are almost black when wet. In some small areas where the surface is slightly undulating, the subsoil has a decidedly reddish shade. As a rule, the topsoil and upper part of the subsoil are noncalcareous, but the lower part of the subsoil is commonly calcareous and contains small lime concretions.

In the hot, dry weather the topsoil bakes hard in uncultivated fields, but shallow tillage maintains a friable surface covering 1 or 2 inches thick. However, even in cultivated fields, the topsoil becomes rather hard below the depth reached by cultivation, in the long periods of dry weather. The upper part of the subsoil when wet is rather sticky, when moist is plastic, but on drying becomes very hard and tough and breaks into small, hard clods only by the exertion of considerable force. At a depth ranging from 10 to 20 feet, the soil is underlain by beds of smooth, rounded quartz gravel and some sand, the fine material being more or less calcareous and the gravel in places being cemented into layers of conglomerate by the lime carbonate. Mapped areas of this soil include areas of fine sandy loam.

Calumet very fine sandy loam is rather extensive in the central part of Wichita County. It occurs in some large areas between Wichita Falls and Electra on the stream-terrace lands which adjoin and lie a few feet above the bottom-land soils along Wichita River and Buffalo Creek. Areas south of Wichita Falls extend westward along some of the larger creek bottoms, and in the vicinity of Kemp City several areas extend southward into Archer County. Some fair-sized areas are along Gilbert Creek southwest of Burkburnett.

The surface of Calumet very fine sandy loam is flat in most places. Surface drainage is slow, and the heavy subsoil is so dense as to cause very slow underdrainage. In depressions, therefore, water often stands for some time after rains. Most of the soil is favorably situated for the application of irrigation water and much of it lies within the irrigation districts. Good water is usually obtained from wells from 18 to 25 feet deep.

A very large proportion of this soil, probably not less than 80 per cent, is under cultivation to the general farm crops of the region. Much of it has been in cultivation for many years. A low, scattered growth of native mesquite trees is seen on uncultivated areas. The native grasses, consisting largely of buffalo and grama grasses with some needle grass and others, form a thick growth which provides good pasturage for livestock. The crops grown are mainly cotton, grain sorghums, wheat, oats, sorgo, and some barley, millet, corn, and Sudan grass. A large part of the land has been cropped continuously to wheat and oats for many years without fertilization, and farm practices have not been such as to restore soil fertility.

In favorable seasons, it is reported that good yields of all crops are obtained. Wheat yields from 15 to 25 bushels to the acre, oats from 30 to 50 bushels, cotton about one-half bale, corn from 15 to 30 bushels, and grain sorghums from 25 to 35 bushels. Sorgo, Sudan grass, millet, and barley also yield well in good seasons. Under the dry conditions which prevail during many seasons, the yields are much lower. In small gardens under irrigation from local lakes or wells, peaches, plums, berries, and vegetables are grown successfully. The soil is reported probably to be best suited to small grains, grain sorghums, and sorgo, though under favorable conditions as to moisture supply all the crops grown give good results. The soil is sometimes spoken of locally as hardpan or as having a hardpan subsoil, though the heavy clay is really a claypan.

Current prices of this land range from $75 to $100 an acre in favorable locations, though some areas near towns and improved roads sell in small tracts for as much as $150 or $200 an acre.

By the incorporation of organic matter and barnyard manure into the soil better yields might be obtained. It is possible that under irrigation the application of too much water might result in water logging and in increasing the quantity of soluble salts at the surface. It probably would be advisable to provide beforehand, outlets for drainage water in fields that are to be irrigated.

CALUMET SILTY CLAY LOAM

The surface soil Calumet silty clay loam consists of dark-brown or dark chocolate-brown silty clay loam. It is underlain, at a depth of 6 or 8 inches, by very tough clay varying in color from very dark chocolate brown to chocolate brown. This grades, at a depth ranging from 18 to 24 inches, into chocolate-brown clay, which is somewhat lighter in color and texture and more granular than the clay above it. It commonly contains small lime concretions. In places, the lower part of the subsoil has a slightly reddish shade. As a rule, the topsoil and upper subsoil layer are noncalcareous, but the lower subsoil material is at least slightly calcareous. In places, a few fine, black concretions occur throughout.

This soil resembles Foard clay loam but occurs on flat terraces underlain by gravel. It is sometimes called hardpan land, on account of the tough claypan subsoil.

Calumet silty clay loam is not very extensive. The main areas are southeast of Iowa Park, in tracts up to several hundred acres in size. Small areas are near Valley View School. The soil occurs on old flat stream terraces just above the river-bottom lands.

The surface of Calumet silty clay loam is nearly flat, with slight depressions here and there, in which the soil is of darker color. In most areas there is a slight slope, but drainage is poor. The lay of the land is favorable for irrigation, and most of it is situated within the irrigation districts. Good well water is obtained at a depth of 20 or 25 feet.

Practically all the Calumet silty clay loam is in cultivation, probably not less than 90 per cent being farmed. Uncultivated areas are covered with the native growth of small mesquite trees and various native grasses, of which buffalo grass is the most abundant. The soil crusts and bakes on drying, though proper cultivation maintains good tilth to a depth of 2 or 3 inches. The soil is said to be rather difficult to manage. It dries so quickly that plowing and cultivation must be done promptly, when the supply of moisture is exactly right, or it becomes too hard. The tendency to crust over after rains sometimes prevents plants from coming up and results in poor stands. The soil is used chiefly for small grains, wheat and oats having been grown for many years. With sufficient rainfall, crop yields are fairly good, but in dry seasons they are very low, as the drought resistance of the soil is low unless a very good supply of moisture has been stored before the crop-growing season. In the most favorable seasons, wheat yields about 20 or 25 bushels to the acre, oats from 40 to 60 bushels, cotton from one-third to one-half bale, corn from 15 to 25 bushels, and grain sorghums about 25 or 30 bushels. Sorgo is also grown successfully, and Sudan grass would doubtless do well.

The current selling price of this land varies from $75 to $100 an acre and is somewhat higher for small tracts near towns.

FOARD VERY FINE SANDY LOAM

The topsoil of Foard very fine sandy loam is chocolate-brown, rather heavy very fine sandy loam ranging in thickness from 4 to 10 inches. When very dry, this soil has a dark-grayish or grayish-brown color at the immediate surface. The subsoil, to a depth ranging from 16 to 20 inches, is chocolate-brown or dark chocolate-brown very tough heavy clay which in places has a decidedly reddish shade. Below that the reddish-brown or chocolate-brown clay is not so tough as in the upper part of the subsoil. A few small, rather soft, black concretions are found in the subsoil. The lower subsoil material generally contains small lime concretions and is calcareous, though as a rule the topsoil and upper part of the subsoil do not effervesce with hydrochloric acid.

In dry seasons, the surface soil of uncultivated areas hardens, and on drying, the upper part of the subsoil becomes very hard and is broken apart with difficulty into rather small fragments. If cultivated when moist, the soil is easily kept in good tilth throughout the dry season. Water passes down through the subsoil when it is dry and cracked, but in wet seasons the dense clay impedes underdrainage. Small bare spots, known as "alkali spots," occur in many places.

Foard very fine sandy loam is the most extensive soil in the county and occurs in large areas in practically all parts. The surface is almost flat, though generally there is a very gentle slope toward the

small natural drainage ways which reach into or cross most of the areas. Surface drainage is rather slow, and in places the water stands for some time after rains. The tough subsoil is very retentive of moisture, and water passes downward very slowly. Much of this soil is favorably situated for irrigation. That to the south of Wichita River is so situated that large areas can be readily watered from the canals of the new irrigation project.

Probably less than 50 per cent of this soil is in cultivation. The remainder is utilized for pasture land and is covered wth a heavy sod of native prairie grasses, a thin growth of widely separated small mesquite trees, and scattered clumps of chaparral. Buffalo, grama, and needle grasses predominate. The general farm crops of the region are grown, and yields vary with the seasons, being fairly good in years of adequate rainfall. Cotton, wheat, and oats are the main crops, and smaller acreages of the grain sorghums and forage crops are grown. In favorable seasons, cotton yields about one-half bale to the acre, wheat from 15 to 20 bushels, oats from 35 to 60 bushels, and grain sorghums from 30 to 35 bushels. Sorgo also yields well. Small quantities of barley and millet are grown successfully by a few farmers. The soil is considered to be best suited for small grains, though cotton is also a crop of importance. The soil does not appear to be very resistant to drought. It bakes very hard except where cultivated, and even then it becomes hard and tight just below the layer penetrated by tillage implements. Probably cotton, the grain sorghums, and sorgo are the most certain crops under droughty conditions. Small orchards and home gardens are seen at some of the farm homes. Peaches, plums, and berries do fairly well where the soil receives plenty of moisture.

This land is valued at the present time at prices ranging from $40 to $75 an acre. The proximity of oil fields and the possibilities of oil development tend to give some of the land a higher price than its use for strictly agricultural purposes would warrant. Also the development of the irrigation project has increased the selling price of this land in the part of the county south of Wichita River.

No fertilizers are used on this land and no special care has ever been taken to preserve its productiveness. It would seem that its productiveneess could be increased by the use of barnyard manure or by plowing under organic matter, such as cowpeas. Possibly sweet clover could be used as a soil improver. The addition of organic matter would lessen the tendency of the soil to become hard in dry seasons. With irrigation this undoubtedly will prove a satisfactory soil for the general farm crops of the region.

The analysis of soil from one of the "alkali spots" shows the presence of a very large quantity of sodium chloride. A system of adequate drainage should apparently be provided in utilizing this soil under irrigation.

FOARD CLAY LOAM

The topsoil of Foard clay loam is dark chocolate-brown or chocolate-brown clay loam from 4 to 8 inches thick. This is underlain by dark chocolate-brown tough clay which, at a depth varying from 14 to 24 inches, grades into brown or reddish-brown clay. This lower subsoil material is more or less calcareous, as a rule, and car-

ries some lime concretions. The topsoil and upper subsoil layers are not sufficiently calcareous to effervesce with hydrochloric acid. In places on sloping areas or where the soil merges with Vernon clay loam the upper part of the subsoil is reddish brown or brownish red. The surface soil is rather sticky when wet, but on drying in summer it becomes very hard. Where cultivated under proper moisture conditions, it has a satisfactory tilth, which may be maintained during the summer to the depth penetrated by tillage implements. The upper part of the subsoil when dry bakes into a very tough, hard mass, which is broken with difficulty into small, hard fragments or clods. The lower subsoil material does not become so hard or tough as that of the upper part of the subsoil. Bare "alkali spots," a few feet in diameter, occur in places but are less numerous than on Foard very fine sandy loam.

Though not a very extensive soil there are several areas of good size closely associated with the Foard and Vernon soils and occurring mostly in the southern part of the county, southwestward from Wichita Falls. Scattered areas are found in the western and southwestern parts of the county. The soil occurs generally as undulating or very gently rolling prairie land, but a few slopes are rather steep, and some rather flat areas have a very gentle slope toward drainage ways. Surface drainage is fairly good in most places, but the underdrainage is usually slow, owing to the heaviness of the subsoil. Much of the soil will lend itself readily to irrigation, but the situation with respect to available water is not generally so favorable as in the case of Foard very fine sandy loam.

Probably not more than 50 per cent of this soil is in cultivation. The remainder is utilized as pasture land. Most of it is virgin, the growth consisting of small, scattered mesquite trees and a sod of prairie grasses, buffalo grass being the most important. Some grama and needle grasses are also present.

The crops grown are wheat, oats, cotton, the grain sorghums, sorgo, and sometimes a little millet, barley, and corn. The soil appears to be fairly productive, and during seasons of sufficient rainfall the yields are good. Small grain, cotton, grain sorghum, and sorgo do well. In good seasons wheat yields from 20 to 30 bushels to the acre, oats from 30 to 60 bushels, grain sorghums from 30 to 50 bushels, corn from 20 to 30 bushels, and cotton from one-half to three-fourths bale. The average yields are very much less than the highest, because of the smaller yields in dry seasons.

Much of this soil occurs in positions favorable to the accumulation of rain water. The farmers state that the soil crusts over quickly on drying after rains, and that this often keeps young plants from coming up. It is therefore difficult sometimes to get a good stand.

The current prices of this land for agricultural purposes range from $50 to $100 an acre. Areas near oil fields have a much higher value. The development of the irrigation project, which includes some large areas, recently has led to an increased valuation.

The humus supply of the soil should be maintained in order to conserve moisture and to prevent crusting. Water should be used sparingly where the soil is under irrigation to avoid water logging and to prevent surface accumulation of water-soluble salts, which

under some conditions might injure crops. Adequate drainage facilities should always be provided irrigated soils susceptible to water logging.

FOARD CLAY

The topsoil of Foard clay consists of very dark chocolate-brown clay. It is underlain at a depth of about 8 inches by dark chocolate-brown clay which is sticky when wet, plastic when moist, and very tough when dry. When wet the surface soil appears nearly black, but on drying it assumes a dark ash-gray tint. In places there is a shallow surface covering of lighter material, consisting generally of chocolate-brown clay loam. At a depth varying from 16 to 20 inches the underlying clay grades into reddish-brown or light chocolate-brown clay which is not so tough as the upper subsoil material and which is more granular. In most places the topsoil and upper part of the subsoil do not show the presence of lime carbonate by field tests, but the lower part of the subsoil is calcareous and contains lime concretions. In some spots lime carbonate and lime concretions are found from the surface down. In other spots the quantity of lime increases with depth.

Foard clay occurs in several small areas in the southern part of the county, the largest occurring in the vicinity of Flannigans Peak near the county line. The surface is nearly flat and drainage is poor. Water passes through the dense clay of the subsoil very slowly. The land, for the most part, is favorably situated for the application of irrigation water.

Practically none of this soil is in cultivation. It bakes and crusts over on drying after rains even more than the clay loam of the series. It is best suited to the production of small grains, cotton, grain sorghums, and forage crops. The crop yields, in the few small patches cultivated, are approximately the same as on Foard clay loam.

VERNON VERY FINE SANDY LOAM

The topsoil of Vernon very fine sandy loam consists of brownish-red or reddish-brown very fine sandy loam. It is underlain, at a depth ranging from 8 to 12 inches, by dark brownish-red clay varying in texture from rather sandy to rather heavy. Below a depth varying from 18 to 24 inches below the surface the subsoil is somewhat lighter in color and contains more fine sand. In places the lower part of the subsoil is calcareous and contains small lime concretions; in other places, especially on the crests of ridges, a thinly layered, partly weathered, fine-grained soft sandstone is associated with the unweathered brownish-red clay. In other places, on slopes or on crests of narrow ridges, more or less disintegrated red beds material carrying the sandstone fragments lies near the surface, giving rise to a subsoil or a lower subsoil layer consisting of partly disintegrated grayish-yellow sandstone mixed with chocolate-red clay. In these places the subsoil carries no lime concretions and is not calcareous.

On a few circular bare spots, locally called " alkali spots," no vegetation grows. The soil contains considerable water-soluble salts, which in places concentrate in a thin, whitish incrustation. In such

places, the surface is very slightly lower than that of the surrounding soils, and the surface cover of fine sandy loam is very thin or entirely absent. The clay, which comes nearly or entirely to the surface, is rather dense, heavy textured and tough. As mapped, this soil includes some areas of Vernon fine sandy loam which differ chiefly in the coarser texture of their surface soil.

Vernon very fine sandy loam, one of the more extensive soils of the county, occurs in many small and in some large areas throughout a belt extending from the southeast corner to the northwest corner. Some of the largest areas are near Burkburnett and southeast of Wichita Falls.

The surface is undulating or gently rolling, though some slopes are rather steep. Many areas occur on the highest uplands, as ridges and low smooth hills. Surface drainage is good, and on some of the steeper unprotected slopes the soil is subject to washing. Practically all of this soil lies outside the present irrigation districts, though a few small areas in the southern part of the county could be irrigated from the present system. Some areas are too high for the available gravity water, and it would be necessary to pump water to irrigate them.

Much of the Vernon very fine sandy loam is utilized for the pasturage afforded by the original native grasses which consist mainly of buffalo grass, grama grasses, needle grasses, and some broom sedge. A very early grass, *Hordeum pilosum*, is also abundant. A scattered growth of small mesquite trees is common on virgin areas. Perhaps 50 per cent of the soil is in cultivation at the present time. Considerable areas have been abandoned because of the development of oil fields. The crops grown are cotton, grain sorghums, sorgo, wheat, oats, and a little corn. The soil is easily cultivated and kept in a friable condition, but uncultivated areas bake hard in hot dry weather. The deeper soil is the most productive, being more retentive of moisture. Cotton, grain sorghums, sorgo, and vegetables succeed better than the small grains. Peaches, plums, and berries are grown on a small scale.

Current prices of improved farm land of this kind range from $40 to $75 an acre. Higher values obtain near the oil fields. Where farmed for some time, the soil appears deficient in humus, and organic matter should be supplied.

VERNON CLAY LOAM

The topsoil of Vernon clay loam is brownish-red or reddish-brown clay loam from 3 to 8 inches thick, and the subsoil is brownish-red or dull brownish-red clay. This grades, at a depth ranging from 18 to 24 inches, into brownish-red clay of lighter texture and color, which is in many places calcareous and which contains numerous small lime concretions. The upper subsoil material is heavy, whereas the lower subsoil material, especially where calcareous, is rather more granular. Throughout a large part of the soil the lower subsoil material is more or less mixed wtih fragmental sandstone. On many of the steeper slopes the parent material of clay and sandstone occurs within 1 or 2 feet of the surface. In some spots a surface covering of red fine sandy loam, from 1 to 3 inches thick, is present. On some of the steeper slopes erosion has carried away

most of the clay loam covering, leaving the clay subsoil exposed. On drying the soil bakes very hard, but it remains friable under cultivation. Small, scattered, rounded, quartz and quartzite gravel appear locally on the surface.

Vernon clay loam is the second most extensive soil in this county. It occurs in large areas in the western half of the county, the largest being near Electra and Iowa Park. There are some rather smooth areas with gentle slopes, but most of the soil is rather rolling, and rather steep slopes are numerous. Drainage is good and in places is so excessive as to cause undue erosion by rain water. Most of this soil lies outside the irrigation districts, and some of that within the districts is too high for irrigation by direct gravity from the main canals. The soil is locally known as tight land because uncultivated areas harden in dry weather. In this hardened condition the soil on the slopes does not absorb water readily.

A very large proportion of this soil is covered with its native vegetation of prairie grasses and is utilized for pasture land for cattle. The native grasses comprise buffalo grass, grama grass, needle grass, and others. There is also a considerable growth of broomweed and a scattering of small mesquite trees and shrubs.

Probably not more than 10 per cent of this soil is under cultivation. Where farmed it is used mainly for the production of cotton, grain sorghums, sorgo, wheat, and oats. Yields of these crops vary largely, depending on the position of the soil and on the rainfall. In years of good precipitation very good yields are obtained on the smoother areas; in dry seasons yields are low and are poorest on the sloping areas where the soil is shallow. The soil is rather droughty. In good seasons the best areas of the soil yield approximately one-half bale of cotton to the acre, from 15 to 25 bushels of wheat, from 30 to 60 bushels of oats, and about 30 bushels of the grain sorghums. On some farms the productive power of the soil has been lowered by allowing the surface material to wash and by adding nothing to maintain the natural productiveness. It seems a rather prevalent practice to devote the lands largely to a 1-crop system of growing small grains or cotton almost exclusively, with small acreages of feed crops, such as the grain sorghums and sorgo. Much development of the oil industry has taken place in areas of this soil, thus discouraging agricultural development to some extent.

Aside from the more or less speculative value of the soil as oil land, it is probably held for prices ranging from $25 to $75 an acre, depending largely on the location, surface features, improvements, and general condition of the land.

Improvement would undoubtedly result from the incorporation of organic matter. It would also be advisable to terrace the land in places to prevent excessive erosion, and surface wash could be prevented to some extent by careful tillage and by running rows and furrows along the contours of the hills, approximately at right angles to the slopes. Much of the soil might be seeded to sweet clover, which would not only tend to improve the soil but would prevent erosion to some extent and provide good forage for livestock. The tendency of this soil to bake would be obviated to a considerable degree by maintaining a good supply of organic matter within the soil, and this practice would also doubtless tend to increase the re-

sistance to drought. As a rule, good well water can not be obtained over many of these areas.

VERNON CLAY

The topsoil of Vernon clay consists of brownish-red or reddish-brown clay from 6 to 10 inches thick. It is underlain by a subsoil of heavy brownish-red clay. In places, this subsoil continues to a depth of 36 or more inches, but in most places, the underlying red beds material comes within 3 feet and in some places within a few inches of the surface. This material is of brownish-red shaly clay containing some bluish shaly streaks or brownish-red and blue partly weathered clay shale. In some places, thin sandstone strata and fragments occur throughout the red beds formation.

Vernon clay is of very slight extent in this county. A small area is within the city limits of Wichita Falls, the largest area, comprising only a few hundred acres, lies about 8 miles southwest of Wichita Falls near the southern border of the county, a small area is northeast of Iowa Park, and another is north of Electra.

Areas of Vernon clay are rolling, and many of the slopes are steep and somewhat eroded and gullied. In such locations much of the surface soil has been washed away. Drainage is excessive, and much of the soil lies in such a position that irrigation is not practical.

Vernon clay is not cultivated. Although not absolutely bare of vegetation much of it has a sparse cover of grasses and a few small, scattered mesquite trees. The native grasses are mainly buffalo grass, some needle grass, and a number of weeds of which broomweed (*Gutierrezia* sp.) is the most abundant. In places, as much as 50 per cent of the surface is bare of any vegetation. The soil absorbs very little water, especially on the hard sloping areas. In some other sections of the Red Plains region of northwestern Texas smooth areas are used successfully for cotton, grain sorghums, sorgo, wheat, and oats, and under favorable conditions of rainfall yields are fairly good. The land here is used for grazing and is not generally considered as being of much value for crops. By terracing the lands to prevent erosion and by the addition of manure and organic matter the soil can be built up to a fair state of productivity. The stiffness and intractability of the soil make cultivation difficult.

Vernon clay, eroded phase.—The term eroded phase is used to indicate areas of Vernon clay that have been so washed and eroded that no surface soil remains in most places. The material is brownish-red clay to a depth of several feet and contains bluish and reddish shaly material. In many places the soil appears to consist entirely of partly decomposed clay shale. It typically consists almost entirely of freshly exposed red beds material without accumulations of true soil. In such places the soil washes away as fast as it is formed by the weathering of the substratum. There are also exposed thin strata of dark and gray sandstone throughout the beds, and fragments of these rocks may be strewn over the surface. This soil is mainly exposed parent material.

A few small areas of soil of this phase occur on the steep slopes and rolling lands in southern Wichita County. Some areas are nearly flat and occur as bottoms of steep-walled basins which, however, have outlets through the small draws or gullies which head in

or flow through them. Other areas are almost rough and broken in places but are hardly rough enough to include within the classification of rough broken land. The land has no agricultural value even for grazing, for, owing to its bare condition and the absence of soil, a few stunted mesquite shrubs form practically the only vegetation.

FOWLKES VERY FINE SANDY LOAM

The topsoil of Fowlkes very fine sandy loam consists of brownish-red or reddish-brown very fine sandy loam. It ranges in thickness from about 6 to 12 inches and is underlain by tough, plastic, heavy, reddish-brown or brownish-red clay which continues to a depth ranging from 20 to 24 inches. Below this the clay becomes lighter red with increasing depth. Lime carbonate is not present in either the topsoil or the upper part of the subsoil, but the lower part of the subsoil is commonly calcareous and contains small lime concretions. A few small, soft, black concretions may also occur in the subsoil. Thin, soft, sandstone strata are embedded in the unweathered clay of the red beds, commonly within 3 feet of the surface.

Fowlkes very fine sandy loam closely resembles Vernon very fine sandy loam, the chief difference being that the upper part of the subsoil of the Fowlkes soil is heavier and stiffer than that of the Vernon. Although the subsoil is rather heavy, it is permeable and allows water to soak gradually downward. In places, there are a few small bare spots which are locally called "alkali spots."

An "alkali spot" on this soil may be described in detail as follows: Yellowish-brown very fine sandy loam 4 inches thick is underlain by reddish-brown heavy plastic clay which is rather moist, in contrast to the extreme dryness of the subsoil in adjacent areas where there is no "alkali spot." Below a depth of about 18 inches, the tough clay contains some white, powdery material apparently made up of very fine crystals resembling gypsum and having a slightly salty taste; below a depth of about 24 inches the clay is extraordinarily heavy and tough and is mottled chocolate brown, gray, and reddish brown; below a depth of 30 inches, small black concretions are abundant and the clay is mottled yellow and brown; at a depth of 32 inches, the material consists of bluish-gray and yellow disintegrated shaly and sandy clay which is somewhat calcareous. Above this, the soil material is generally not calcareous, judging from the reaction with hydrochloric acid, though a few lime concretions are in the topsoil and upper part of the subsoil.

Fowlkes very fine sandy loam occurs in small scattered areas throughout the central and southern parts of Wichita County in close association with the Vernon soils. Mapped areas include areas of Foard very fine sandy loam which are too small to be shown separately on the soil map.

The surface of Fowlkes very fine sandy loam is generally rather smooth and undulating, though the soil also occurs on slight swells and ridges. As a rule, the surface is more nearly flat than that of Vernon very fine sandy loam, and some of the soil lies in positions suitable for the application of irrigation water.

Probably not more than 10 per cent of this soil is under cultivation, the greater part of it remaining as native prairie. A few scat-

tered small mesquite trees grow on it. The grasses are the same as those growing on Vernon very fine sandy loam. The crops and yields are about the same as on the Vernon sandy soils. The soil appears to be best suited to cotton and the grain sorghums, and with adequate rainfall the yields are fairly good.

The land is held for about the same prices as are the Vernon sandy soils.

FOWLKES CLAY LOAM

The topsoil of Fowlkes clay loam, consisting of brownish-red or chocolate-brown clay loam, is underlain at a depth of 6 or 8 inches by dark brownish-red, tough, plastic clay. Below this, at a depth ranging from 18 to 24 inches, the lower subsoil material is somewhat lighter in color and texture and continues to a depth of 36 inches where it grades into the unweathered or partly weathered clay of the red beds formations. The substratum commonly does not occur within a depth of 3 feet. The soil looks very much like Vernon clay loam, the chief difference being that the upper subsoil layer of the Fowlkes soil is rather tough and plastic. The lower subsoil material, in many places, is calcareous and carries some small lime concretions, though the topsoil and upper subsoil layer do not, as a rule, show lime carbonate by the field test.

Fowlkes clay loam occurs in a number of small areas in the west-central part of the county in the vicinity of the Triangle Ranch. It is closely associated with Vernon clay loam.

Areas are undulating or gently rolling, not so sloping as a rule as many areas of Vernon clay loam. Surface drainage is good, but the downward movement of water is retarded by the dense clay subsoil.

This land is largely in pasture. The original prairie growth, consisting of scattered small mesquite trees, buffalo grass, and some needle and grama grasses, remains over practically all of it.

The soil is suited to about the same crops, and the yields would probably be about the same as on Vernon clay loam.

PORTLAND VERY FINE SANDY LOAM

Portland very fine sandy loam is chocolate-brown loam underlain, at a depth of about 10 inches, by heavy very fine sandy loam, loam, or clay loam of the same color. The color becomes lighter at a depth ranging from 24 to 30 inches, and the subsoil contains more sand in the lower than in the upper part. In places, the lower subsoil material is brownish red or reddish brown. Field tests in most places show sufficient lime carbonate in the topsoil or subsoil to effervesce with hydrochloric acid. In some places the lower part of the subsoil is slightly calcareous. The soil, as mapped, includes small areas of very fine sand.

Portland very fine sandy loam is widely distributed over the county in the narrow creek bottoms. The main areas occur along the forks of Pond Creek, and along Holliday, Gilbert, Buffalo, Long, and China Creeks.

Areas of this soil are nearly flat or slightly depressed in places. Drainage is fairly good. The occasional overflows usually do not cover the surface for very long periods and do little damage.

Probably 90 per cent of this soil is in cultivation, and the remainder is covered with native trees and grasses. Scattered mesquite trees grow on the land, along with some chittam, hackberry, elm, pecan, and a few other trees. Buffalo grass, bunch grass, needle grass, and some grama grasses grow naturally and provide good pasturage. The main crops are cotton, small grains, grain sorghums, corn, and sorgo. In good seasons, the yields are fairly high. In one small field alfalfa has been grown for several years. It produces very good yields when rainfall is good. It is said, however, that the crop has suffered considerably from root rot, a fungous plant disease. In very dry seasons crops do not suffer so much on this as on some of the upland soils. In good seasons cotton yields from one-half to three-fourths bale to the acre, corn from 15 to 40 bushels, wheat from 15 to 25 bushels, oats from 30 to 40 bushels, and grain sorghum about 30 bushels. The soil is also well suited to vegetables, berries, and small fruits.

No large areas of this soil occur on any one farm, but it is so well suited to a variety of crops that any small area is desirable and is utilized by farmers if possible. The land has no separate selling price, as it constitutes only a very small part of farms, but its presence increases the value of farms in proportion to its extent.

PORTLAND CLAY LOAM

The topsoil of Portland clay loam is dark-brown or chocolate-brown clay loam or silty clay loam about 8 inches thick. The subsoil is chocolate-brown clay or clay loam, underlain in many places, at a depth ranging from about 18 to 24 inches, by chocolate-brown or reddish-brown very fine sandy loam. Although the surface soil is rather uniform in color and texture, the subsoil is rather variable in both these features. As a rule, the lower subsoil material is somewhat lighter in color and coarser in texture than the topsoil and upper part of the subsoil. The topsoil and subsoil are commonly noncalcareous. In places mapped areas of this soil include small areas where the topsoil is clay. Some of the largest of these areas are along Buffalo Creek 1 or 2 miles southwest of Iowa Park.

Portland clay loam occurs only on narrow creek bottoms, mostly in small patches associated with Portland very fine sandy loam. It occurs in the western part of the county along creeks which flow into Wichita River. The largest area is along Buffalo Creek west of Iowa Park.

Portland clay loam has a flat surface which in many places is slightly depressed below that of adjoining soils. Many areas at some distance from the stream gather and hold considerable water for some time. Natural drainage is poor, though this is not a serious trouble, owing to the light rainfall. The surface is sometimes covered with overflow waters from the creeks, though such inundations are infrequent and of short duration.

The greater part of this soil is covered with the native growth of trees and grass. The trees are mainly mesquite and the various trees that grow on the other bottom-land soils. Probably less than 20 per cent of the soil is in cultivation. The same crops are grown as on Portland very fine sandy loam, and the yields are approxi-

mately the same. The soil appears well suited to cotton, small grains, grain sorghums, and corn. It is rather difficult to work, but a friable surface layer can be maintained by proper cultivation. The soil is so inextensive that it is comparatively unimportant in the county.

RIVER WASH

River wash includes the areas of river-bed material occurring along Red and Wichita Rivers. It consists of deep beds of water-transported sand ranging in texture from very fine to coarse and in color from grayish or light flesh to very light chocolate and even chocolate red in some of the layers or pockets of the finer-textured material. Small waterworn gravel of quartz and other rocks are scattered over the surface, and are present, in places, through the mass beneath. A few clay balls are also present on the surface as well as through the matrix of sands.

This sand-bed material is from 1 to 5 feet above the river at low stage and is prevailingly flat, with a gradual downstream grade. Slight surface inequalities result from wind and receding water ripples, miniature benches are along the low-water grooves through the sand, and hummocks of wind-drifted sand have accumulated about such obstructions as a cocklebur plant where the immediate surface sands have dried at low-water stage, the prevailing stage of the rivers of this region.

Ordinary high water covers all the areas of river wash, and each overflow alters the surface configuration in the miniature fashion described. As the flood waters subside a network of channel ways is formed. Many of these split apart and rejoin farther downstream. The receding water flows through this system of braided channels, finally confining itself to the lowest trenches or grooves, whose bottoms are, in the deepest places, only a few feet below the surface of the river bed.

When the river is low, as it is most of the time, the material dries and wind drifts of sand are constantly moving about over the surface. Some of the finer particles are blown out to adjacent higher bottoms and even on the uplands form strips of aeolian soil of markedly uniform characteristics as compared with the varied soils back from the bluffs. Sand particles are driven with such stinging force during a strong wind in the dry season that it is sometimes decidedly uncomfortable for one facing this wind as he stands on the higher ground near the edge of an area of river wash. The finer particles are carried farther away, but the coarser ones are dropped near the place of origin; that is, on the river bed. On the river bed itself, sand is seen piled in hummocks about such minor obstructions as a weed or clay ball. If left undisturbed for a time, willows, cottonwood, grasses, and weeds sprout on the hummocks, and as they grow serve as a catchment obstruction, causing increased accumulation of wind-blown material and gradual rise of the surface. Overflows of the kind that merely cover the hummocks without washing them away lay alluvial deposits over the aeolian material. This process continues and the height and size of the islands increase, until finally such stable islands as Hamill Island are developed. On these, miniature dunes are formed and continue to grow until formidable dunes result.

The vertical section through river wash shows characteristic banding of dark and light colors, chiefly light flesh and gray, which contrast very much more in color than the laminated material of the dunes. These banded water-stratification or deposition lines in many places vary but slightly in texture but may be marked by a noticeable difference in the shade of the material. These bands or seams are of varying thickness, most of them being several times thicker than the wind-laid laminations of the dunes. They are commonly horizontal or approximately so.

The mass of material constituting river wash under flood conditions assumes an almost fluid state and moves downstream in wavelike fashion. It is exceedingly unstable as far as place is concerned. Very little of this material is found along Wichita River, but rather extensive areas are along Red River. It has no agricultural value whatever, and save for that part which in dry seasons is lifted by wind and removed to adjacent higher ground and that which is built into more or less permanent higher bottoms and dunes, it represents river debris in progress to the sea. The material built into the higher bottoms and dunes is subject to erosion along the sides by flood waters and is not permanently placed. The material is never dry to any great depth, water being found within 12 inches of the surface in the deepest places during the driest seasons. This is simply subsurface water which is flowing downstream at a slower rate than that which flows over the surface during floods.

DUNE SAND

Dune sand consists of gray, loose, fine sand which is light brown or grayish brown when moist. In places, the surface soil is very slightly loamy. The gray color of the surface material continues downward to a depth varying from 2 to 8 inches. Below this depth it changes gradually to pale yellow, and this color becomes more distinct with depth. In most places, the subsoil below a depth of 15 inches is distinctly yellow, though the material in places has a faint-reddish tinge. In other places, the subsoil is reddish yellow or even light chocolate red, but for the most part the subsoil is loose, pale-yellow or yellow fine sand. Both topsoil and subsoil are loose, though where slightly loamy the soil forms a somewhat hard mass during long periods of hot dry weather. Very small areas of other soils occur throughout mapped areas of dune sand in the low, flat, or depressed patches. These soils consist mainly of the fine sand, fine sandy loam, loamy very fine sand, very fine sand, and silty clay loam of the Yahola series. Dune sand is commonly calcareous, owing doubtless to the calcareous silt and very fine sand blown up from the dry river bed and from areas of river wash.

Dune sand is not very extensive in the county, though it comprises considerable areas of the low bottom lands along Red River, forming a broken band across the northern county border. Some of the most typical areas are north of Electra and north and northwest of Burkburnett in the Big Bend district of the disputed lands in the oil field between Grandfield and Devol Bridges.

The soil occurs as dunelike areas on the low flat benches along Red River. Some of the dunes are partly bare of vegetation, and the sand drifts about in the winds. Most of the dunes are from 3 to

10 feet above the general elevation of the flat bottoms, but some are about 15 feet high. They are from 20 to 100 feet across, and many are in the form of long, narrow ridges. These ridgelike areas are from 10 to 20 feet high and extend for a mile or more in places, running parallel to the river bed, that is, in a more or less east-west direction, with a southerly trend in places. In some places the dunes are so close together as to merge into one another over considerable areas. Many of the low, flat areas commonly occurring between the dunes extend in narrow belts parallel to the ridges or dunes and in these places are subject to overflow. Most of the dunes, however, are not inundated to any great extent, even during the highest overflows.

None of the dune sand is in cultivation. If plowed it would blow and drift so badly that it would be useless for crops. Grasses, including one or two species of Andropogon (probably *A. scoparius*), considerable bur grass, many weeds, and some bear grass, grow on this soil. The land is used only for grazing. Small patches of the Yahola soils lying between the dunes and dune ridges could be used for some crops, but most of these areas are too small and disconnected to make farming them worth while. Plums and berries might be grown on some of the smoother dunes, provided rainfall were sufficient. Sweet clover might be grown over areas in the depressions and even on some of the dunes, thus affording good pasturage for livestock.

ROUGH BROKEN LAND

The classification rough broken land designates areas of land which have been so denuded of soil and dissected with erosional gullies that they are entirely unsuited for farming. These areas comprise steep rough slopes, gentle eroded slopes, and rolling areas. There is a network of gullies, having short, steep slopes or long, steep, bluff-like declivities. The surface material varies from the worn red clay of the red beds formation to various other materials of diverse origin intermixed with fragments of sandstone and limestone. Some rock beds crop out in places as ledges, and rock fragments are strewn over some of the slopes, but, as a rule, the land is not very stony.

Land of this kind occurs north of Wichita River where the high rolling prairies touch the river bottoms, and one area is in the northern part of the county on bluffs touching the Red River bottoms. In this latter area there is no stony material, and the land consists of gullied and broken, very steep slopes.

This land is of slight extent. It will never be suitable for farming and affords only scant grazing for livestock, the growth of grasses being very thin. Small scrubby mesquite trees and other shrubs grow in places.

ROUGH STONY LAND

Rough stony land includes small areas of land very similar in every respect to rough broken land, except that the stony material is more abundant. The stone consists of large and small rock fragments broken from ledges and outcrops. Rough stony land is of no value, except for the scant grazing it affords. It occurs in several small areas in southern Wichita County.

IRRIGATION

Dry-land farming has been practiced since the region was first settled. The farmers have depended on rainfall to supply the moisture needs of crops. This practice has given variable results, often very unsatisfactory, as in many years the rainfall is insufficient for the needs of growing crops, and yields have often been much lower than the soils are capable of producing under favorable moisture conditions. Very good yields of crops are obtained when the rainfall is ample, and the results of small irrigation projects on a few farms have shown that the soils are productive and if given proper moisture offer no difficulty to growing crops successfully.

A small area of land has been in irrigation for several years in the vicinity of Wichita Falls, the water supply having been obtained from Lake Wichita, which provides water for city use. The soils thus irrigated are chiefly the very fine sandy loams of the Wichita and Calumet series. For a few small, individual irrigation systems, the water is obtained either from small reservoirs holding storm water that has been impounded or from wells from which the water is pumped. Some of the truck farmers near Wichita Falls have used city water for irrigation. When the city water supply is low they have used well water drawn by means of small pumps.

The chief crops that have been grown under irrigation on the small truck farms are vegetables, fruits, and berries. A small acreage of cotton, corn, and feed crops has also been grown. The results with all these crops have been very satisfactory, and yields have been high and profitable.

With a view to irrigating a large acreage of land in the region, a project has been inaugurated that will enable the irrigation of considerable land in Wichita Valley. This consists of a huge storage dam, about 50 miles southwest of Wichita Falls on Wichita River, which will create a reservoir having a capacity of 525,000 acre-feet of water. About 20 miles down the river from the storage dam another dam has been built to impound water in another large reservoir from which it will be diverted into a main canal carrying it to Wichita Falls. Lateral canals will carry the water from the main canal to the various areas of land to be irrigated. One large lateral crosses under the river southwest of Iowa Park and follows the lowlands in a course generally parallel to the river. The reservoir at the diversion dam covers about 3,900 acres and the water here will be maintained at a constant level by being drawn in sufficient quantities at various times from the main reservoir above. This is done by allowing the water to run down the river bed. It will be held at the diversion dam and drawn off into the main canal as needed.

The initial cost of the irrigation system, including the construction of dams and canals, surveys, and other expenses, was about $4,500,000. Some land was irrigated in 1924, and in 1925 a considerable area was provided for.

At present about 110,000 acres of land are included in the districts covered by the system. Of this total the engineers calculate that about 80,000 acres are suitably situated for irrigation. Large areas of land suitable for irrigation join the area of the project, and it is

planned to extend canals at some future time to provide water for the irrigation of much of this additional land.

The drainage area of Wichita River and its tributaries, which will provide water for the storage reservoir, is 2,000 square miles. Most of the area thus drained consists of Permian Red Beds lands.

The principal soils that will be irrigated are the Foard, the Calumet, and a large number of the Miller and Yahola. Wichita very fine sandy loam will also be irrigated to a considerable extent. Small areas of the Vernon soils will be irrigated, and some of the other less important soils. Some of the Yahola sandy soils will probably be rather leachy and offer problems in getting the water well distributed. The soils on the whole lie well for the application of water. The very heavy, tough subsoils of the Foard and Calumet soils will probably take water slowly, and some trouble may be experienced as a result of applying too much water for this slow underdrainage. The soils may become water-logged, and the quantity of deleterious soluble salts at the surface may be increased, with consequent damage to crops.

ALKALI

In a region as far east as this, there seems to be no need for apprehension that alkali should become a serious menace to agriculture under irrigation, if care is used in applying the water and in maintaining adequate drainage. In places where irrigation is practiced, the danger from alkali has been increased by the use of too much water, especially where drainage conditions are poor. Such danger is usually greatest in arid regions where the soils contain a large percentage of soluble salts that are harmful to plant growth and where the water used for irrigation carries a certain proportion of these salts. Although it does not seem likely that alkali will become a problem in this region, it is possible that small areas of some of the soils having tough subsoils may give some trouble if too much water is used or if adequate outlets are not provided for the removal of the excess water.

On many farms a few small spots are nearly or entirely bare of vegetation. These are locally called "alkali spots." Native vegetation is almost entirely lacking where the land is not cultivated, whereas in cultivated fields there may be a very sparse growth. Farmers state that, in very wet seasons, a fair growth and small yields are made on these spots. Most of the spots are from 10 to 20 feet across and are nearly round or oval in shape. They occur largely on flat areas, along very gentle slopes, or at the base of rather steep slopes. A thin incrustation of white, powdery material forms over the surface of these spots after rains. All the "alkali spots" appear to be associated with soils having dense, heavy, tough subsoils. Under poor drainage conditions these spots may form or become enlarged if too much irrigation water is used.

The water that will be used for irrigation does not appear to contain a large percentage of soluble salts. A sample taken from the river when there was a considerable flow of water was analyzed by G. S. Fraps, State chemist, with the following results:

	Parts per million		Parts per million
Carbonate of lime	76	Chloride of soda	658
Sulphate of lime	522		
Sulphate of magnesia	128	Total	1,402
Chloride of magnesia	18		

Suspended material 1,202 parts per million.

Of these substances, the sulphate and chloride of magnesia and the chloride of soda are injurious to plants when they are present in considerable quantities, but the amounts shown here are not sufficiently large to cause damage to crops or to accumulate in the soil in large quantities where drainage is good. Local engineers maintain that as the water accumulates in the storage reservoir, the percentage of salts is becoming less all the time.

The topsoil of the "alkali spots" is in many places only 1 or 2 inches thick and is underlain by tough, heavy clay. Samples taken in one of these spots were analyzed by Doctor Fraps, and the soil from the surface down to bedrock may be described by this succession of layers: 0 to 1 inch, brown very fine sandy loam; 1 to 9 inches, tough chocolate-brown clay, containing white concretions; 9 to 20 inches, chocolate-brown clay, containing fine whitish crystalline grains; 20 to 42 inches, chocolate-brown tough calcareous clay, with white concretions; 42 tc 76 inches, chocolate-red fine sandy clay, containing white and black fine concretions; 76 to 84 inches, fine-grained sandstone with interbedded fine sandy loam or the parent rock and other materials of the red beds formations.

Table 5 gives the results of water analyses for soluble salts.

TABLE 5.—*Water analyses for soluble salts in various layers*

Salts	Parts of soluble salts per million parts of water at a depth of—					
	0 to 1 inch	1 to 9 inches	9 to 20 inches	20 to 42 inches	42 to 75 inches	75 to 84 inches
	Parts	*Parts*	*Parts*	*Parts*	*Parts*	*Parts*
Carbonate of lime	250	205	138	276	165	191
Sulphate of lime			1,163			
Carbonate of magnesia	55	90		63	45	56
Sulphate of magnesia			676	137		
Carbonate of soda	102	56			203	138
Sulphate of soda	244	682	2,249	659	505	487
Chloride of soda	360	2,889	4,127	4,552	2,209	1,861
Nitrate of soda	125	185	61	107	67	54

Although there are a number of injurious salts in the soil, chloride of soda is shown to be the most abundant and is perhaps responsible for the failure of good plant growth on these spots. On land with a dense clay subsoil it is possible that the excessive use of irrigation water would tend to increase the proportion of water-soluble salts in the soil unless good drainage were provided. As some of these salts are very soluble, they could be washed or partly washed from the soil in well-drained areas by flooding the land heavily, as is done in some of the irrigated sections of the West.

A sample from an area of normal soil about 100 feet away from the "alkali spot" showed the following characteristics and the proportion of water-soluble salts given in Table 6: 0 to 8 inches, brown

heavy very fine sandy loam; 8 to 16 inches, chocolate-brown heavy very fine sandy loam; 16 to 29 inches, chocolate-brown very heavy, rather tough clay; 29 to 47 inches, dark chocolate-brown rather tough clay; 47 to 98 inches, light brownish-red sandy clay, very calcareous and containing many white concretions and some small black ones.

TABLE 6.—*Results of analyses for soluble salts in a normal soil near an alkali spot*

Salt	Parts of soluble salts per million parts of water at a depth of—				
	0 to 8 inches	8 to 16 inches	16 to 29 inches	29 to 47 inches	47 to 98 inches
	Parts	*Parts*	*Parts*	*Parts*	*Parts*
Carbonate of lime	295	231	220	205	184
Sulphate of lime		36			
Carbonate of magnesia	68		43	131	117
Sulphate of magnesia	158	41	90	33	
Chloride of magnesia	2	106	12		
Carbonate of soda					69
Sulphate of soda				36	140
Chloride of soda	457	599	342	211	289

These analyses show that the proportion of salts in the normal soil is much lower than in the alkali spots. There is a marked reduction in the chloride of soda, indicating, possibly, that this substance may have some bearing on the condition and the lack of productivity of the alkali spots.

SUMMARY

Wichita County is in north-central Texas. It comprises an area of 624 square miles.

The county is rolling prairie dissected by two large valleys and numerous small tributary valleys. It has a general eastward slope. Most of the land is smooth, though there are some small areas of rough lands. Elevations range from about 900 feet to 1,250 feet above sea level.

Drainage is good, as all parts of the county are reached by small streams. Red River drains all of the county, though most of the run-off water goes into Wichita River which empties into Red River just outside the county.

The population is chiefly white, and 31.3 per cent of it is classed as rural. Wichita Falls, an oil and wholesale center and one of the larger cities of the State, is in the county. Burkburnett, Iowa Park, and Electra are towns of fair size and importance.

The county is served by several railroad lines. The highways are good, several being of cement or gravel.

The climate is subhumid and rather variable. Farming operations are often rendered unsatisfactory by lack of moisture.

The principal crops are wheat, cotton, oats, grain sorghums, corn, grass, and coarse forage. About 80 per cent of the land is in farms. Of this total an average of nearly 200 acres to the farm is classed as improved land. Beef cattle are produced on a number

of fairly large ranches. Some hogs are raised on nearly all farms. Poultry raised on all the farms supplies products for home use and for market. A number of dairies furnish the local markets with milk. Many farmers sell milk to the two creameries in the county, and many sell butter locally.

A number of oil fields are in operation in various parts of the county, creating a rather large demand for some local farm products such as meat, butter, poultry, eggs, vegetables, and fruit.

The yields on different soils vary greatly over the county, many of the sandy soils yielding better than the heavy soils in dry seasons.

The main cash crop on all the farms is either cotton or wheat. Cotton production is being extended over larger areas every year. Subsistence crops for livestock are raised by all farmers. The farms are well stocked with good work animals and are supplied with good farm machinery. Farm homes and buildings are fairly good.

No fertilizers are used. Labor is scarce and demands high wages. The size of farms is given by the census of 1920 as 411.9 acres, 48.4 per cent of which is classed as improved land. Only 29.3 per cent of the farms are operated by owners. In the share system of rental used one-fourth of the cotton, one-fourth of the wheat, and one-third of the corn and grain sorghum are paid the owner.

Wichita County is in the "Red Beds" region on the eastward margin of the Great Plains. The larger part of the soils is of residual origin, but considerable areas are alluvial and old sedimentary soils. Some wind-blown soils are very drought resistant.

The red beds clays, with associated interbedded sandstone layers, gave rise to the largest areas of soil in the county. The sedimentary soils are deposits of materials washed from red beds areas.

The county, though in a prairie region, is covered in most sections with a scattered growth of small mesquite trees. These do not, as a rule, extend north of the Red River-Wichita River drainage divide. Bottom land along creeks and along Wichita River supports some elm, hackberry, cottonwood, pecan, chittam, and other trees. The principal native grasses are buffalo, needle, grama, and bunch grasses, with some mesquite grass and bluegrass.

The largest areas of alluvial soils along Wichita River are high benches above overflow. Small areas of the low bottoms are sometimes inundated. The soils of the Red River bottoms are more sandy and less valuable than those along Wichita River. They are low and are sometimes inundated. The soils along the rivers are calcareous, but those along the small creeks are not calcareous.

The soils of the county are grouped into 9 soil series including 25 soil types and 5 phases. The soil series are the Vernon, Fowlkes, Foard, Wichita, Calumet, Enterprise, Yahola, Miller, and Portland.

The Vernon soils do not lie in such positions that large areas can be irrigated. They are rolling, reddish prairie soils. Vernon clay loam is utilized principally for grazing, as considerable of its area is included in large ranches.

The Foard soils are smooth and flat dark prairie soils utilized largely for small grains. These soils are characterized by the toughness of their subsoils. They are probably better suited to small grains than to other crops, though under favorable conditions all crops can be grown. Large areas are suitably situated for irrigation.

The Fowlkes soils are of very small extent. They differ from the Vernon soils chiefly in the greater toughness of their subsoils.

The Calumet soils are dark flat terrace soils characterized by structural features very similar to those of the Foard soils. These soils are probably best suited to the production of small grains and are used largely for these crops as well as for others. Areas in many places are suitably located for irrigation.

The Wichita series includes reddish terrace soils closely associated with the Calumet soils. The soils are well suited for growing practically all the general crops of the region and for producing vegetables, fruits, and berries. Some areas lie within the irrigation district in positions favorable for irrigation.

The Enterprise series includes wind-blown soils of chocolate-brown color. These are mostly valuable soils and fairly drought resistant. The dune phase of these soils is not suited to farming, as the soil is so loose that it blows and drifts in the winds where it is not covered with grass. These soils do not lie within the irrigation districts.

The Yahola soils are chocolate-red soils of the river bottoms. They have sandy subsoils. They are rather productive, except for the very sandy members of the series, which are too light and loose to yield good crops. These soils are calcareous, and the heavier members are well suited to all the crops grown and to alfalfa and sweet clover. The Yahola soils are favorably situated for irrigation.

The Miller soils are the chocolate-red soils of the Wichita River bottoms. They closely resemble the Yahola soils but have heavy subsoils. They are very productive and are suited to all the crops grown in the region and to alfalfa and sweet clover. Large areas of these soils lie favorably for irrigation within the irrigation districts.

The Portland soils are the chocolate-brown soils along the small creeks. They do not appear to contain much lime. They produce good yields of all the crops of the region when rainfall is sufficient.

River wash, dune sand, rough broken land, and rough stony land are miscellaneous classifications of soils which are largely non-agricultural.

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[PUBLIC RESOLUTION—No. 9]

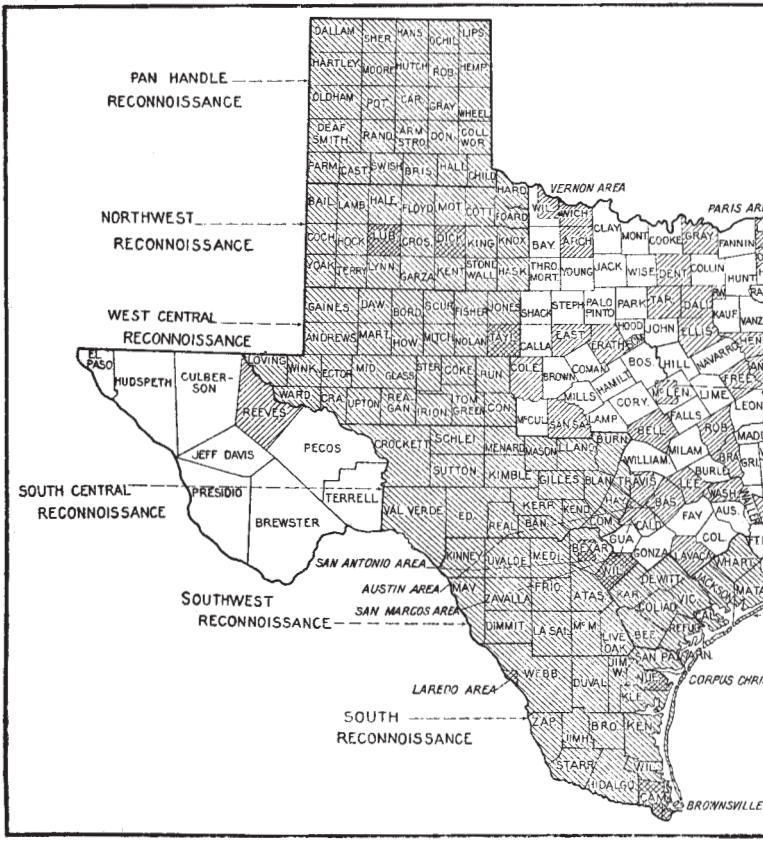
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture"

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils, and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]



Areas surveyed in Texas, shown by shading

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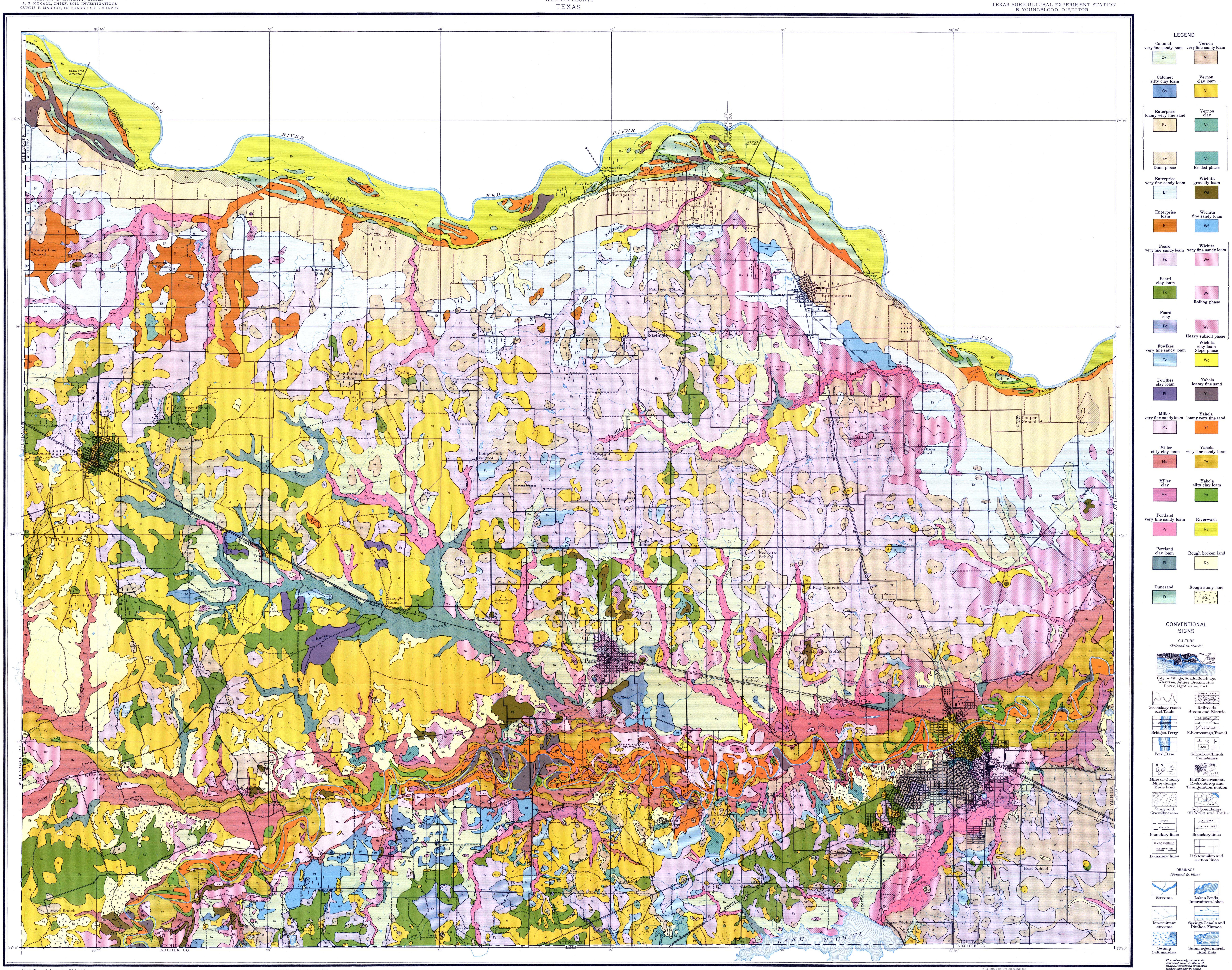
U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
HENRY G. KNIGHT, CHIEF
A. G. MCCALL, CHIEF, SOIL INVESTIGATIONS
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP

WICHITA COUNTY
TEXAS

TEXAS AGRICULTURAL EXPERIMENT STATION
B. YOUNGBLOOD, DIRECTOR



H. H. Bennett, Inspector, District 4.
Soils surveyed by William T. Carter, in charge, and
W. W. Strike, U. S. Department of Agriculture, and H. V. Geib,
and E. H. Templin, Texas Agricultural Experiment Station.

BASE MAP IN PART FROM
U. S. GEOLOGICAL SURVEY SHEETS

Scale 1 inch - 1 mile

WILLIAMS & HEINTZ CO, WASH., D.C.

Field Operations
Bureau of Soils
1924